THE GLASS INDUSTRY

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THE USE OF ARSENIC IN THE GLASS INDUSTRY

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EDITOR'S NOTE:

Recent developments have caused a shift in the availability of raw materials for the glass industry. In many cases, this shift has been accompanied by a change of the economic point of view governing their application. The glass producer of today is, therefore, more than ever interested in an accurate knowledge on the performance of different constituents in his glass, and in a clear statement concerning the courses which have led to their use. Only this knowledge enables him to judge whether, or how, they can be replaced, or which property will suffer when the constituent in question will no longer be obtainable. In order to gather this information and to present it to our readers, we have asked workers in this field to describe the role of different, more important constituents. The demand for compilation of this material originated from the readers who want to obtain specific information, exceeding the scope of the usual text books.

Arsenic and glass melting have been associated for centuries. Arsenic is a byproduct of many metallurgical operations where it is easily separated from the ore by its volatility. This sublimation process makes arsenious oxide, As_2O_3, easily available in a relatively pure state. Its earliest use in ceramics was as an opacifying agent. In enamels, especially in those for jewelry purposes, and watch dials, arsenic remained the chief opacifier for a long time.

Arsenic can be obtained in the vitreous state when its vapor is cooled rapidly or when crystallized arsenic is melted under pressure. Nevertheless, As_2O_3 cannot be considered an actual glass forming oxide. like B_2O_3 as it does not impart its ability to form glass to its compounds. Glassy arsenic has a structure which is principally different from that of other inorganic glasses and it rather resembles organic materials in its constitution. The glassy modification of arsenic has to be treated as a different chemical individual, a polymer of As_2O_3 with different chemical properties. Whereas crystallized arsenic does not reduce an aqueous solution of gold chloride the glassy modification can do so according to an observation of J. W. Retgers (1893).[1] Later E. Jenkel[2] made a special study on the difference between the two forms of As_2O_3 in their behavior towards $AuCl_3$. Glassy arsenic has been produced commercially and has been widely used in the European glass industry. The chief application was as a blocking agent. Today the use of arsenic in the glass industry is that of a minor batch addition.

Arsenic as well as the pentoxide As_2O_5 have not gained any importance as glass formers. The latter, however, especially in the form of aluminum arsenate, Al_2O_3, As_2O_5 or $AlAsO_4$ might well deserve further investigation. The structure of this compound is related to that of silica and is analogous to that of the aluminum orthophosphate which is rapidly gaining interest as a constituent of special glasses. Its main disadvantage is its instability in contact with reducing gases at high temperatures.

All the arsentic used in the glass industry enters the batch as a minor constituent, but as such, it has to perform some very important functions. The effects of arsenic in glasses, glazes and enamels might be classified into six groups.

I. Arsenic as an Opacifying Agent

Probably the oldest use of arsenic in ceramics is that of an opacifier in low melting jewelry enamels. Arsenic as such has no particularly high refractive index ($n_d = 1.75$) but in lead glasses it readily forms lead arsenate or a compound corresponding to an apatite ($n_d = 2.14$).

As we will see from the chemistry of arsenic compounds, there is a strong tendency to form the pentavalent oxide As_2O_5 at high temperature. Only in this form arsenic takes part in the formation of the opacifying phase. This is of more than mere theoretic interest as the pentavalent arsenic is much less poisonous than the trivalent. It would be highly desirable in the interest of those workmen who have to handle batches of arsenic opal glasses to introduce this element as calcium or lead arsenate rather than arsenious oxide.

The lead arsenate opacification became famous for its density and whiteness. O. Emmerling (1896)[3] reports an analysis of one of the best French enamels, where he found 3.75 per cent As_2O_5. The base glass consisted of a rather simple potash lead silicate glass containing 37 per cent silica, 53 per cent lead oxide, 6 per cent potash and 0.5 per cent sodium oxide. Such an enamel is not very resistant but seemed to be of sufficient durability for watch dials and similar purposes. Gradually its com-

position had been improved by adding boric oxide and feldspar to the batch. Today the chief and maybe the only application of these dense white opal glasses is for the white stripes in thermometers, capillaries, and burette tubes.

The field of arsenic opal glasses has been studied chiefly from the point of view that excessive use of arsenic represents a possible source of defects in glass as it develops cloudiness on re-heating.

K. Fuwa (1924)[4] published a series of experimental melts where between 5 and 25 per cent arsenic was added to glasses of two types, namely: $6SiO_2$, RO, $1.3R_2O$ and $6SiO_2$, B_2O_3, R_2O.

L. Riedel (1926)[5] published a short note on his observation that 3 per cent of arsenic caused opacification when introduced into a soda-lime-glass under oxidizing melting conditions. Of particular interest is an observation of Hundeshagen (1931).[6] In his discussion on defects in glass he mentioned the fact that arsenic is especially likely to produce cloudiness when small amounts of chlorides are present.

Most of our knowledge on the subject is derived from the work of M. Parkin and W. E. S. Turner.[7] These authors introduced increasing amounts of arsenic into a soda-lime-glass batch and studied the behavior of the resulting glasses on reheating. The temperature of devitrification was found to vary with the amount of arsenic introduced, ranging from 575°C to 700°C. The most interesting feature observed by these authors is that the character of devitrification varied in different glasses. Below a certain amount of arsenic devitrification took place at the surface only. If more than 10 parts of arsenic had been added to 100 parts of sand, the devitrification of the glass occurred throughout its mass and the devitrified product represented a porcelain-like material. But even when these large amounts of arsenic were present, surface devitrification was likely to occur at lower temperature.

Due to recent work on the reaction of As_2O_3 containing glasses with gases, we are now in a position to explain this behavior. The surface devitrification is a consequence of the increase of As_2O_5 concentration at the glass surface. When arsenic is introduced into a glass in the trivalent or pentavalent form an equilibrium is established between As_2O_3 and As_2O_5 but only the As_2O_5 causes opacity. Kühl, Rudow, and Weyl[8] found that heating a glass containing As_2O_3 in oxygen or air causes a shift of the equilibrium, increasing the As_2O_5 concentration. At 500° C already the diffusion speed of the oxygen into the glass is high enough to account for an appreciable increase in the As_2O_5 concentration at the glass surface. For a given temperature treatment the critical concentration causing opacity is reached in the surface layer much earlier than in the interior of the glass.

H. P. Rooksby[9] studied the crystalline phase in a dense white opal glass having the following batch composition:

Sand	34.0%
Red lead	48.0%
Potassium nitrate	2.5%
Potassium carbonate	7.5%
Arsenious oxide	5.0%
Borax	1.5%
Alumina	1.5%

The X-ray patterns made it probable that $Pb_3(AsO_4)_2$ is the opacifying phase although no direct comparison with a compound of this composition was made. Rooksby discusses the possible structure of this lead arsenate in respect to the structure of the crystals of the apatite group. The mimetite $3PbAs_2O_8.PbCl_2$ belongs to the apatite group of minerals, which is known for its stability. W. A. Weyl[10] recently offered apatite formation as the most probable explanation for the phosphate opal glasses. The same explanation would also hold true for opacification with arsenic, especially in lead and calcium containing glasses. Lead arsenate has a structure similar to that of an apatite, but its structure is greatly stabilized and strengthened when chlorine enters the crystal lattice. This offers an explanation of the observations of Hundeshagen who found that traces of chlorine enhance the cloudiness of soda-lime glasses containing excessive amounts of arsenic.

II. Arsenic as a Blocking Agent

In its glassy state arsenic represents heavy chunks of porcelain-like appearance with a density of 3.7. When such a chunk of arsenic is thrown into the glass pot, it immediately sinks to the bottom. At the temperature of the glass melt arsenic has a very high vapor pressure resulting in a rapid volatilization and an intensive stirring action. Arsenic, therefore, has been used for making the pot-glass more homogeneous and for removing bubbles and seeds. When used as a blocking agent only relatively small amounts of arsenic remain in the glass melt. The main part bubbles through the glass and has the same effect as other blocking agents, such as a wet piece of wood, or a potato submerged into the melt.

III. Arsenic as a Fining Agent

Somewhat related in scope but fundamentally different in its action is the use of arsenic as a batch addition for the purpose of fining. As a rule arsenic is added to the glass batch in combination with niter.

The reasons why the glass melters first introduced arsenic into their glasses is not exactly known. Already in Kunkels edition of the Ars Vitraria (1679) arsenic is mentioned in batches for crystal glass. The later reference books which mention arsenic, do so in a different and often confusing sense. J. Henrivaux (1897) claims that it aids fusion of the melt, whereas E. Tscheuschner stresses the mechanical stirring action of arsenic bubbles escaping from the melt. Besides that, however, he recognizes its chemical action. With the introduction of pyrolusite as a decolorizing agent it offered a convenient means to check the pink color caused by excessive manganese.

So far as the fining is concerned the mechanical picture of As_2O_3 bubbles sweeping out the seeds was generally accepted. Hovestadt mentions that arsenic remained in the glass and O. Schott explained this as the consequence of its oxidation by the niter. The general belief was that practically all the arsenic volatilizes from the melt. This, however, is not true. In contrast to the blocking, arsenic remains in the melt when added to the glass batch. Especially in the presence of niter arsenic forms As_2O_5 or arsenates, during the early stages

of melting and these compounds are relatively stable at high temperatures, and decompose only gradually in the fining period. Oxygen is then liberated, and oxygen rather than arsenic vapor, bubbles through the melt. The discrepancy between the viewpoint of O. Schott and the old concept of the function of arsenic in glass melting stimulated S. R. Scholes (1912)[11] to some experiments which would enable him to decide which of the views expressed is the correct one. He confirmed that indeed most of the arsenic remained in the glass, and so he pointed out that the volatility cannot be used for explaining the fining effect of arsenic.

At about the same time F. Gelstharp[12] published a discussion on a series of chemical reactions pertaining to the manufacture of plate glass. In this work he paid particular attention to arsenic in the batch and he emphasized that its action could not yet be fully understood as too little was known about its chemical reactions with the batch constituents and that further research was needed. Gelstharp found that not only under oxidizing conditions arsenic remained in the melt, but even in the absence of niter As_2O_5 was formed. Of great help for all further research on the chemistry of arsenic in glass was the work of E. T. Allen and E. G. Zies,[13] who developed the method of determining As_2O_3 and As_2O_5 in glass. With the help of better analytical control, it became possible to prove that As_2O_3 oxidizes at low temperature, forming As_2O_5. The arsenates formed decompose at high temperature and the oxygen liberated is the actual fining agent. The volatility of arsenious oxide cannot be considered any more the primary cause of its action. Nevertheless some As_2O_3 volatilizes gradually from the glass and Frink[14] even found bubbles in a glass which contained a film of As_2O_3 crystals.

Further studies on the oxygen evolution from arsenic containing glasses by Salmang and Becker,[15] as well as by R. H. Dalton,[16] have much contributed to support this picture. Kühl, Rudow, and Weyl[8] studied the reverse reaction, namely, the absorption of oxygen by glasses which contain arsenic in its trivalent state. This reaction is responsible for the disappearance of small gas bubbles containing oxygen when the glass is cooled from the fining to the working temperature. The tiny oxygen bubbles which did not find a chance to rise to the surface and escape from the melt can be reabsorbed by oxidizing the trivalent to pentavalent arsenic. Whereas all these investigations served to clarify the chemical behavior of arsenic in glass, W.E.S. Turner and his collaborators[17-20] studied the technological side of the problem. The contributions of the Sheffield laboratory are published in a series of papers dealing with the reactions of arsenic in soda-lime-silica as well as in lead glasses. From Turner's work we obtain the first clear statement that even under practical plant conditions, nearly all the arsenic remains in the glass. This holds true for amounts up to about 0.5 per cent and only if this amount is exceeded—which is not customary in ordinary glass melting—volatility becomes noticeable. This is in agreement with the laboratory melts of S. R. Scholes.

Firth, Hodkin, and Turner were able to carry out tests on a large scale during the melting and refining of a soda-lime-magnesia silica glass, made from a batch containing niter and arsenious oxide. After the glass was melted, it was "blocked" or "plunged," with a charge of 9 ozs. of As_2O_3. The experience of the plants, where these melts were carried out, had been that the glass which was melted overnight could not be got ready without the assistance of arsenious oxide. The amount of arsenious oxide was one pound per mixing of 236 pounds of batch. Proof samples were drawn from the glass at different stages. The first was one quarter of an hour before blocking with arsenious oxide. The times at which the subsequent samples were taken are stated in Table I.

TABLE I.

No.	Sample taken at	Total arsenic as As_2O_3 per cent	Arsenic as As_2O_5 per cent	Arsenic as As_2O_3 per cent
1	7:45 p.m.	0.46	0.47	0.05
2	8:30 p.m.	0.45	0.47	0.04
3	10:30 p.m.	0.45	0.45	0.06
4	11:30 p.m.	0.46	0.50	0.03
5	12:15 a.m.	0.45	0.44	0.07
6	1:15 a.m.	0.44	0.41	0.08
7	2:15 a.m.	0.45	0.39	0.09
8	3:15 a.m.	0.46	0.39	0.12
9	4:15 a.m.	0.46	0.39	0.12
10	5:15 a.m.	0.46	0.39	0.12
11	6:15 a.m.	0.46	0.40	0.11
12	7:00 a.m.	0.46	0.33	0.18

The authors describe the melting procedure and their results as follows:

"The melting temperature at 3 o'clock in the morning when the stoppers were taken down was approximately 1440°, and from this point onwards until 7 o'clock it fell progressively to 1250°. During this period between 3 o'clock and 7 o'clock the seed gradually disappeared, probably by re-solution in the glass. It was stated, however, that if the plunging with arsenious oxide was not applied this seed could not be got rid of until some time in the afternoon.

Apart from the effect of the arsenious oxide in assisting the refining in the batch referred to, it seemed of special interest to us to follow the course of the arsenic content of the glass throughout the refining period. The table states the result of the analysis of the different samples for total arsenious oxide and for the amount of the arsenic present respectively as As_2O_5 and As_2O_3.

There are several quite striking features in the results. The first is that most of the arsenic added to the batch was retained in the glass as shown by the results for sample No. 1. The second is that the arsenious oxide used for plunging the glass appears wholly to have escaped, since in sample No. 2, taken one half-hour after plunging, the total arsenious oxide was 0.45 per cent as compared with 0.46 per cent before treatment.

The third point is the high proportion of arsenic to arsenious oxide due in part, no doubt, to the presence of niter in the batch.

Next it will be seen that the total amount of arsenic remains constant right through the refining and cooling-off period. The amount of arsenic oxide suffered some diminution with time as the glass remained in the furnace, but whether due to dissociation or to reduction through the furnace atmosphere must remain somewhat uncertain."

In order to exaggerate the dissociation of As_2O_5 in the melt, another series was carried out at considerably higher temperature. The glass was melted at 1500° C and blocking was omitted.

TABLE II.

EXPERIMENTS ON ELIMINATION OF ARSENIC WITH TIME OF HEATING OF THE GLASS

Pot: 50 lb. open. Temperature: 1500°
Founding Period: 45 hours
Calculated amount of As_2O_3 in glass = 0.75 per cent

Founding period measured from last charging (hours)	Per cent arsenic in the Glass		Total as As_2O_3
	As_2O_3	As_2O_5	
3	0.23	0.59	0.74
4	0.21	0.60	0.73
24	0.33	0.39	0.67
28	0.26	0.30	0.52
32	0.25	0.28	0.49
36	0.25	0.22	0.45
40	0.27	0.20	0.45
45	0.29	0.14	0.42

The results of the open pot melting at 1500° C show a progressive loss throughout the melting period. It is interesting to notice that the loss seems to be much greater during the 21 hours of standing as glass, namely, from the 24th hour to the 45th hour, than during the first 24 hour period which includes the initial loss due to charging. The As_2O_5 content shows a steady diminution which suggests a slow dissociation of the higher into the lower oxide. From these large scale experiments, we learn that there exists an equilibrium between As_2O_5 and As_2O_3 in technical glass melts. As_2O_5 forms in the initial state and is rather stable at high temperature, decomposing only slowly liberating a steady stream of oxygen. The oxygen bubbles sweep out carbon dioxide, water, and other gaseous residues, thus fining the melt. In case they become too small to rise, resorption of the seeds takes place on cooling.

IV. Arsenic as an Oxidizing Agent

Closely related to the role of arsenic as a fining agent is its influence on the color of a glass as it is caused by the presence of iron, as an impurity. The oxygen produced during the decomposition of arsenates partly prevents and slows down the dissociation of the Fe_2O_3 in the glass melt. It raises the "internal oxygen pressure" of the glass so that a faint green iron color results rather than the dark bluish color which would appear without the presence of such an oxidizing agent. We can describe the function of arsenic in other words, and say: arsenic takes over the oxygen of the niter at low temperature, stores it, and makes it available at high temperature when it is needed most.

A more quantitative picture of the influence of arsenic on the color and the FeO-Fe_2O_3 equilibrium was obtained by Kühl, Rudow, and Weyl[21] who determined the light absorption of a glass containing 5 per cent iron when increasing amounts of arsenic were added. Two series of iron glasses were investigated. The one contained arsenic alone, the other arsenic in combination with niter.

In both cases, the addition of arsenic caused a decrease in the red and infra-red absorption, indicating that the iron oxide equilibrium is shifted to the side of the Fe_2O_3 or ferric ion. The color of the glass changes from a dark bluish to a lighter yellowish green. The combination of niter and arsenious oxide was found to be much more efficient than As_2O_3 alone. It was surprising, however, to find that even in the absence of niter, As_2O_3 can act as oxidizing agent. In order to explain this apparent contradiction we refer to the chemistry of arsenic, especially to the studies of Reissaus.[22]

The simple reaction: $As_2O_5 + O_2 = As_2O_5$ cannot take place even in the presence of alkali or other basic oxides. When arsenious acid or its salts are roasted in air, they seem to oxidize for As_2O_5 compounds are formed. This change however, takes place on heating, whether oxygen is present or not. Reissaus described it by the equation:

$$5\ As_2O_5 = 3\ As_2O_5 + 4\ As$$

The oxygen or oxidizing agents react with the metallic arsenic and change it back into As_2O_3 which again can decompose forming As_2O_5 in metallic arsenic.

In the mixture with sodium-and calcium carbonate, the glass batch, As_2O_3 changes into As_2O_5 on heating even if the batch does not contain niter. Only in this case, when no oxidizing agent is present 2/5 of the arsenic introduced into the batch volatilizes and is lost. As this is highly undesirable and might even give rise to brown discoloring of the glass, arsenic should always be used in combination with niter and it might even be advisable to introduce it as pentavalent arsenic directly. Calcium arsenate, for instance, is commercially available and should have the advantage of eliminating a health hazard to the worker.

Another reaction of interest to the glass melter where the As_2O_3 or better, the As_2O_5, acts as an oxidizing agent, is the effect of arsenic in selenium pink glasses. This color is due to a very delicate balance between the elemental selenium and different selenium compounds in the glass melt. It is, therefore, not surprising that selenium pink is greatly affected by addition of arsenic. Selenium pink is not only of interest to the producer of colored glass, but it is a constituent of all glasses decolorized by selenium compounds. The experienced glass melter knows that additions of arsenic greatly affect the pink color and that more selenium is needed than in arsenic-free glasses. Arsenic decreases the intensity of the selenium pink by shifting the equilibrium from the pink elemental selenium to the colorless selenite. This is illustrated by an instructive report which H. Löffler[23] gives of a case in a Bohemian glass plant. The glass contained a relatively high amount of arsenic—1 pt. to 100 pts. of sand. In order to develop the desired pink, 250 g. of metallic selenium had to be used in the batch. When the arsenic content was lowered to 1/5 of its original value, the same pink could be accomplished with only 50 g. selenium. In the same base glass, but with arsenic completely eliminated, 7 g. of selenium proved to be sufficient for producing the pink.

It could be demonstrated by a striking experiment, that the arsenic had oxidized the selenium into a colorless compound. Using 10 pounds of the original pink glass as cullet, a whole pot of pink glass could be produced without further additions of selenium. The colorant, therefore, was not burned out or volatilized by excessive fining of the glass but had merely changed into a colorless compound.

Other reactions where arsenic plays the role of an oxidizing agent are less characteristic. Among these is the removal of carbonaceous material and sulphides. In carbon amber glass, arsenic should be omitted as it interferes with the development of the color.

V. Arsenic as a Reducing Agent

Once the oxidizing effect of arsenic was established, the question came up—how its influence on the color of manganese glasses could be explained. Manganese occurs in a glass in two different valencies. In the divalent state it is practically colorless, whereas in the trivalent state it gives rise to a deep purple color. Even in extremely small quantities, manganese can impart a pinkish color to glasses when melted under oxidizing conditions. Reducing agents destroy the pink color and so does arsenic. Nevertheless, the idea seemed unacceptable that arsenic should act as a reducing agent. Salaquarda[24] even went so far as to doubt the oxidizing effect of As_2O_3 on iron, as its behavior towards manganese establishes its reducing action.

To the man trained in chemistry, this apparent contradiction however, should not offer any difficulties. There are many examples where a strong oxidizing agent can act as a reducing agent too. Hydrogen peroxide, for instance, which is well known for its oxidizing power reduces gold chloride or silver compounds to the metals. We cannot speak of oxidizing agents or reducing agents in general, but have to refer to the system in which they are used. Stannous chloride, for instance, can act as an oxidizing as well as a reducing agent towards sulphur dioxide, depending upon the acidity or basicity of the medium. We have many examples of this type in glasses and arsenic is the outstanding. Arsenic, or better, the mixture of As_2O_3 and As_2O_5 as an oxidizing agent in respect to iron, but as reducing agent, in respect to manganese and chromium. Very similar is the action of antimony. Both are used to improve the green color of chromium glasses where they cause a purer, more saturated green by removing the yellowish cast of the chromates. Also in manganese glasses they can be used when the manganese color has become too intense. In earlier times when manganese in the form of pyrolusite was the only decolorizing agent for glasses, arsenic was used to compensate any excess of pink. W. M. T. Gillinder (1854) in his book on glass melting, advised the inexperienced melter to use a little more pyrolusite than necessary to compensate for the green iron color as it offers no difficulty to take away the excess pink by throwing arsenic into the melt. The opposite case, insufficient manganese can no longer be repaired after the melt is completed.

VI. Arsenic as a Stabilizer of Colors

The fact that arsenic forms an equilibrium between two different states of oxidation, both of which are colorless, provides an excellent means to "buffer" the effects of fluctuations in the furnace atmosphere.[25] In colored glass and in decolorized glass where substances such as manganese and selenium are used, the color is greatly affected by variations in melting conditions, especially in the composition of the furnace atmosphere. Manganese, as well as selenium, are powerful colorants but both occur in equilibria with a colorless state of oxidation. Only the smallest part of the manganese introduced into a glass is present in its coloring trivalent state. Most of it forms colorless divalent manganese. Similar is the situation with selenium. Also here most of the selenium introduced is present in the form of colorless selenite and only a small part is responsible for the pink color. We can imagine that in such a system a slight shift in the oxidation-reduction equilibrium causes the color either to disappear completely or to be considerably intensified. When arsenic is present the As_2O_3 and As_2O_5 concentration is much higher than that of the elemental selenium or of the trivalent manganese. If the furnace atmosphere should change accidentally, to more oxidizing or more reducing conditions, the arsenic is affected earlier than the colorant and, therefore, acts as a "buffer."

This is the reason why for decolorizing glass and even for selenium pink, the glass melter prefers to use arsenic with his colorant even if much more of the colorant is required than in glasses free of arsenic. Arsenic, therefore, has certain stabilizing action and both states of oxidation are colorless. Consequently many melters do not like to switch over to the other oxidizing and fining agents such as cerium and sodium sulphate.

Disadvantages of Arsenic

Arsenic is the cause of certain characteristic defects which have been recognized for some time, but no remedy has yet been developed. In glass tubings and rods which have to be reworked, arsenic additions might be detrimental. As_2O_3 readily splits off metallic arsenic on heating, especially under reducing conditions. Such glass is liable to show gray and brown spots during lamp working.[26]

Another defect caused by excessive arsenic has already been mentioned—the cloudiness. Excessive arsenic, especially in glasses high in lime or lead oxide causes turbidity, due to precipitation of highly insoluble arsenates. Arsenates in larger quantities are not compatible with silicates, but resemble phosphates in this respect. Turner found that large amounts of arsenic make a glass unmeltable and lead to the formation of porcelain-like materials.

That does not exclude that in the usual small concentrations arsenic compounds—especially the arsenates of the alkalis—might have a beneficial effect on the melting speed. There is no doubt that in special glasses such as highly siliceous glasses or heavy barium crowns,[27] arenic improves the meltability, but it would be going too far, to call it a fluxing agent. Reliable data on this effect of arsenic are not yet available and the results of laboratory melts would be of limited value for the glass industry. Only the experience of the glass melter can give the correct answer, for he is the only one who can correlate, melting speed, fining speed, and refractory attack. From this point of view, also, the whole problem of how the arsenic content of a glass affects refractory corrosion shall not be touched in this paper.

One of the most serious handicaps of the user of arsenic is that he cannot apply decolorization with rare earth-oxides. From a theoretical point of view, the combination of neodymium oxide with cerium oxide comes closest to the ideal decolorizer. Unfortunately, a glass containing small amounts of these rare oxides in combination with arsenic is liable to discolor in sunlight. If cerium and arsenic are present in a glass, dark brown colors develop when the glass is exposed to daylight. Even traces of arsenic seem to be sufficient to cause this

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ONE EXTRA TOOTH

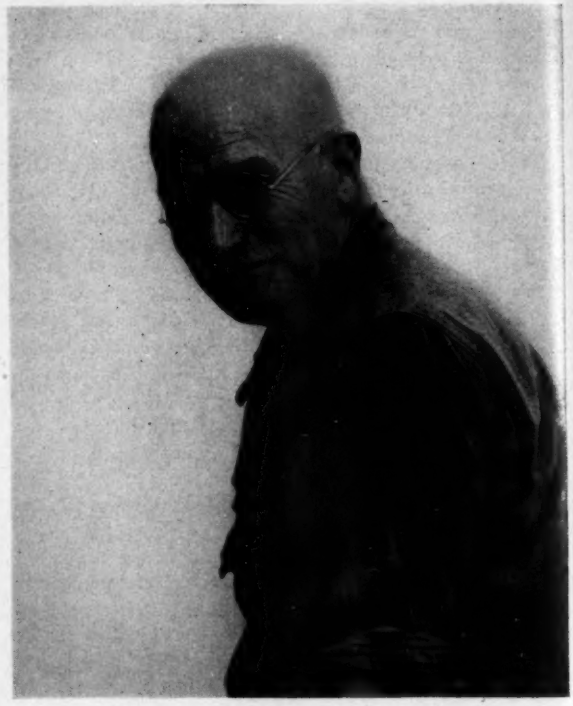
By F. W. PRESTON

With the death on April 19th, 1942 of James Carrie, the principals of this story have nearly all passed away, some at their appropriate three score years and ten, and some who drank their cup a round or two before. Of the rest, if they be still living, all are believed to be abroad, in England or in Central Africa, never to return. While there still remain a few of us who know the story, though not so well as the principals, it seems advisable to set it down, checking our recollections with one another and with such documents as may be available.

It is more than twenty years ago now, that the vision came to Carrie in a dream. He told me long since that never in his waking hours had he envisaged such a contrivance, but in his dream he saw the machine, and saw it working, and understood how it worked. It was a machine for grinding and polishing great rectangular slabs of marble or granite, for in those days Carrie was concerned with the stone-cutter's trade. It must have been about the time of the First World War, but it was not the only time that Carrie dreamed his mechanisms into existence. And it seems clear that his subconscious mind grasped mechanism better than his conscious one; for while he had served a long apprenticeship to the mechanical engineering art, he had left school very young and had no mathematical or other learning. This is no reflection on his conscious mind, for, as the sequel will show, a number of engineers with university degrees fell into the pit with him, and helped him to fall in, when they tried to improve on that original vision, which was perfect from the start.

I may add here that Carrie, though completely free from superstition, himself attached great importance to these visions, and always spoke of them as a source of final authority. If he saw the thing, whatever it was, from a grinding machine to an airplane, working in his dream, then in his eyes the thing had been prophesied and in a sense explained. For him, it was the way things came into existence. Before a thing could be made of metal, it had first to be visualized, to exist as a product of the scientific imagination, and it was in sleep that this power of visualization reached furthest into the future. He died without seeing some of his dreams materialize; but that was not because the dream was faulty, but because the means of materializing it were not adequate as yet. Though decades or generations should pass without fulfilment, and he himself should pass away, yet he never doubted that not one jot or tittle should fail of ultimate realization.

But a vision was not merely a prophecy, it was a mandate, an order to construct the thing, if possible. So Carrie used to make drawings or models of his dream machines. In the present instance the design was specific, working drawings could be made, and Carrie showed them to his associate Charles A. Grice. The machine consisted of a rectangular table which moved slowly back and forth on a track. Over the track was suspended a fixed axle, on whose lower end was a fixed large spur-gear. Four planetary axles circulated around this, with spur gears of half the size, but driven through idlers, so that the motion was retrograde. When used as a polishing machine, two standard 18″ felts were mounted on a short cross arm at the bottom of the planetary spindles, and when their phase relationship had once been properly



James Carrie

adjusted, the resulting motion was such that each felt described a long narrow ellipse, set at 45° to the table edge. One of each pair of felts described, so to speak, a NW to SE ellipse, while the other described a SW to NE one. In other words, the major axes of the two ellipses were at right angles and each was at 45° to the travelling axis of the table.

The area covered jointly by the two ellipses, on each of which four felts were circulating, was nearly a square, and by reciprocating the table, the area could be elongated into a rectangle, as long as might be desired; all parts would get ground and polished, and though Carrie did not fully understand it, all parts would get substantially the same amount of polishing. This last point was more important than either Carrie or Grice grasped at the time, but they saw that the machine had possibilities not merely in the stone cutter's field, but in that of plate glass polishing. William Sawyer of Milwaukee associated himself with them to carry through the early development, and later Frank Troutman of Butler joined the triumvirate. The machine itself is described and figured in U. S. Patent No. 1,375,129: a corporation called the Plate Glass Machine Corporation was formed to complete the development.

The experimental machine was duly built and tested,

and about the year 1921 was operating very successfully in the old boiler room of the Standard Plate Glass Company at Butler, Pennsylvania. The utility of the thing, as applied to plate glass, was apparently envisaged as arising from the saving of the great quantity of cullet that had to be laid on the marginal portions of the circular decks of the big polishing machines then in use. For on these big circular decks, some of them 25 feet and some 36 feet in diameter, after a few big plates had been set in plaster, many small and uneconomical pieces had to be set to make up the general periphery. These were necessary to the operation of the machine, but were mostly valueless afterward.

Carrie's machine avoided this difficulty, but it had a further possibility. The Ford Motor Company, about this time, had developed a continuous grinding and polishing line, to make windshields for automobiles. This was before closed cars became the rule, and automobiles used no glass except in the windshield. It was also long before the advent of laminated glass as a standard product. The glass Ford used was ¼" plate, the same thickness as in big store fronts, but in much smaller pieces. The width of the Ford table was about four feet, and for many years the quality of the polish remained poor. None the less, the straws were pointing the direction of the wind; Pittsburgh Plate was considering, or had begun, the development of a continuous process; and the Standard Plate saw in Carrie's machine the chance to develop a continuous process of their own. For the reciprocating motion of the table was not necessary. A continuous motion in one direction would do equally well, provided that several, or many, machines were used in series.

There is no doubt in my mind that in those days Carrie's machine was the best in process of development. It was somewhat more complicated than any of the others, but the complications were neither costly in the first instance nor difficult on the score of maintenance. It is rather that the other machines in process of development were primative than that Carrie's was complex.

His machine spread the polishing-effort more uniformly than the others across the width of the table, so that all parts tended to become finished simultaneously, whereas the others tended to polish the edge, or portions near the edge, long before the center. His machine, by keeping a square of glass under operation at one time, permitted the glass to be kept somewhat uniformly warm, not leaving certain parts to become intermittently cold. Finally his machine, by the criss-crossing of the two elliptical tracks, "picked up the rouge and slapped it down" first in one direction and then in another, much more effectively than the simple circular motion of the other machines.

With this machine offering so much in prospect, Frank Troutman, the President of the Standard Plate Glass Company, felt justified in setting the stage for a program of radical revision and expansion. He felt certain that continuous grinding and polishing was the process of the future, and he had no space long enough for such an operation. Around the plant, the accumulated débris of forty years cluttered the landscape with "sow-bellies," acres and acres of them, twenty feet thick. The place was completely fenced in with them, and was being slowly strangled in its own refuse. To pass outside this area, and put in a long "continuous" on some vacant site, did not solve the problem. Before the glass could be ground and polished it had to be melted and "cast," and to truck or freight the rough-rolled glass any great

Frank Troutman

distance did not look very practicable, though it has since been proved so by Libbey-Owens-Ford and others. To Frank Troutman it did not look very convenient or wise, and he felt he must have a casting hall adjacent to the grinding and polishing plant: but a casting hall is a very expensive affair, and a bright idea occurred to him.

Down at Springdale, on the Allegheny River, the Heidenkamp Plate Glass Company had a fine new casting hall, and a very antiquated grinding and polishing department. The machinery in this department could be junked, and a long narrow hall set free for a continuous grinding and polishing set-up. The first step was to acquire the Heidenkamp plant, and merge it in the Standard Plate Glass Company's organization. This was easily done, though the price paid was too high, and in fact too much high finance seems to have entered into this and several unrelated but nearly contemporaneous, moves. At the time, plate glass was selling at very high prices, but such prices would not be expected to last, and if the timing were wrong, and the continuous process were not installed and quickly successful, the Heidenkamp plant would be a dead loss.

The wisdom of these financial moves is outside the province of this discourse; nor am I qualified by intimate knowledge of those moves to pass judgment upon them. But Frank Troutman did tell me of the technical purposes behind some of those moves, and there was considerable merit in them. They were not necessarily the wisest moves that could have been made, but, except for the technical mistakes that followed, they might have worked out quite well; and if they had, he would have been commended for that for which he later was condemned.

The crux of the whole situation was a question of size.

Carrie's machine was a success, but it was polishing a strip of glass only 7 feet wide. This is plenty wide enough for windshields, but is not wide enough for store fronts, and store fronts sell at a much higher price per square foot than windshields. It was decided to make Carrie's machine big enough to handle a strip of glass 10 feet wide.

On this simple decision, the whole structure of Carrie's dream-machine broke down. Neither Jim Carrie, who was a mechanic, nor Frank Troutman, who was an engineering graduate of Lehigh, nor Jim Cruikshank, then the outstanding consulting engineer in the plate glass field, who was called in on the job, knew how to make the transition. What is worse, none of them clearly realized that they didn't know. The decision to increase the width of the machine was not Carrie's; the problem of producing something that would work was dumped in his lap.

For business reasons, a prompt solution was wanted. Carrie's original machine was a success; the Heidenkamp situation could not be exploited properly without it. The ten-foot machines had to be designed in a hurry.

Now if the machine could have been "photographed up," it would still have worked, but the 18″ polisher blocks would then have become 27″ or so in diameter, and would have to weigh something like 300 lbs. apiece. Now polishers have to be replaced at intervals, and this was then, and in general is still, a hand operation. The weight of the block has to be limited to that which a strong man can conveniently lift. Pittsburgh Plate later developed a method of removing the whole machine when they wanted to renovate the polish felts, but even so they stuck to a small size block.

With an 18″ felt, the size in general use at the time, Carrie's machine naturally and economically comes out as one ideally suited to a table width around 7 feet. With a 10 ft. width, eight felts, each of 18″ diameter, seemed to provide too little polishing power. Bigger felts were not practical, so Carrie used 12 of the 18″ size, putting a three-legged spider on the foot of each planetary axle, thus getting three ellipses instead of two, each ellipse being tracked by four felts.

Although he never explained it to me, I have a feeling that Carrie knew he was doing something wrong. He was being disobedient to the heavenly vision, which called for only two felts on a simple cross bar, not three on a tripod. Without the necessary mathematical knowledge to make the problem clear to himself or his associates, he was somehow aware that something was not right. He realized that parts of the glass were not going to get properly polished. In an effort to rectify the situation, he introduced a "hunting tooth." Instead of making the sun gear exactly twice the diameter of the planet gear, he introduced one extra tooth on the central stationary gear. This caused the ellipses to "precess" around the "sun." From that point on, the battle was lost. Some slight smoothing out of the polishing effort was achieved, but an intractable mechanism had been devised which admitted of no amendment. No amount of doctoring could henceforth make a well machine of it.

At this stage of the game, though the battle was lost, the campaign might have been saved. A single machine of the ten-foot width might have been constructed and tried out at moderate cost. Certain proposed changes on the grinding machine (as distinct from the polishing machine) might also have been tried out. But there was need for haste. The haste was not of Carrie's seeking, and entirely contrary to his nature; for no-one was more meticulous than he in insisting on seeing his way through a problem before starting to construct the apparatus.

But here he was over-ruled. As soon as he had devised a tentative scheme for dealing with the ten-foot strip, the designs were pushed through Mr. Cruikshank's offices, the machines were constructed, and a sizable building at the Butler plant set aside for the experimental runs, until such time as the main plant at Springdale could be outfitted.

In the haste, not even the grinding machines were correctly proportioned. There was not sufficient overhang of the "runners," and the grinding took place too much at the center of the strip which might be ground as thin as 3/16″ while the edges were still 3/8″. To correct this with a ten-foot glass strip, would have been quite difficult. It would have called for cutting down the reinforced concrete supports, and some other complications. The only remedy would have been to narrow the strip to perhaps 8 feet. But this would not solve the problem of the polishers.

The story of the attempt to make that plant run is well known to many still living. It is said that eight hundred thousand dollars went down the sink.

Because the width had been increased, the rate of travel could be slowed down; because the available space was short, it had to be slowed down. Because the space was short, only a few machines could be used anyway. There were, I believe, just six polishers. The result was great local heating, and very uneven heating, of the glass, and perpetual breakage. There were other defects, too, which were absent from Carrie's original machine. But most or all of them might have been remedied.

The technical problem, however, now became subsidiary to, and conditioned by, the economic ones. The price of glass was falling rapidly; stock market manipulations had boosted Standard Plate stock to unreasonable heights and then left it to drop unsupported. The timing of the program had failed. Carrie never had a chance with his original creation, the thing that really worked; nor with any modification of it that was scientifically designed or properly tested at each stage.

In the absence of this development, Frank Troutman's bold projects proved altogether too bold. The Heidenkamp plant had to close down. Other affiliated organizations had to be sold. The Plate Glass Machine Company was disbanded and wound up. Grice returned to England, after spending most of his adult life in the States. Carrie for a time was left without visible means of support.

The blows fell thick and fast on many who had no direct responsibility for any of these misfortunes. Among them was Richard Stilwell, superintendent of the Butler plant. When it became clear that the large output expected from "the continuous" was not going to materialize, the Directors demanded of the existing machinery a quality and quantity of glass that could not be ob-

(*Continued on page* 277)

THE LIGHT TRANSMISSION OF AMBER GLASSES

During the past few years there has been much discussion regarding the light transmission of colored glasses, especially those that might be used for protecting certain pharmaceuticals from the deleterous action of light. While the range of glass colors is quite wide only the amber glasses seem to meet the requirements of mass production, low cost and the necessary protection.

Amber glasses of the soda-lime-silica type may be produced by two methods, either by carbon and sulphur combinations or by the addition of iron and manganese oxides in the proper proportions. The light transmission of the carbon-sulphur type has been fairly completely investigated due in part to their availability in this country but little is known regarding the light transmission of the iron-manganese oxides type as only small amounts of this type are made (especially at the present time as manganese oxide is one of the critical materials).

Recently, Holland and Turner[1] reported the results of an investigation on the variation with temperature (20° C to the softening point) of the spectral transmission of glasses. Included among the colored glasses were three amber glasses of the iron oxide-manganese oxide type, two being light amber in color and one black amber in color, and one amber glass in which the carbon and sulphur combination was used as the coloring material. By taking the 20° C data from the curves as given by Holland and Turner a comparison of these two types of amber glasses may be made. Table I lists the chemical composition and color description of these four glasses.

TABLE I

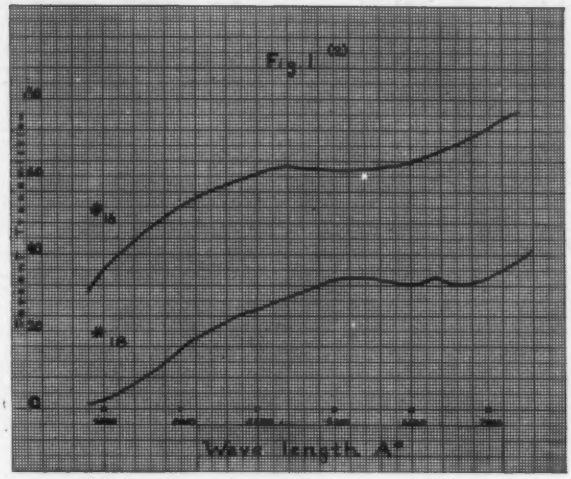
AMBER GLASSES

	Composition in Per Cent Glass No.			
	16	*17*	*18*	*21*†
SiO_2	66.80	67.87	63.89	69.93
$T:O_2$	—	0.10	0.22	0.058
Al_2O_3	3.20	1.06	2.90	1.58
Fe_2O_3	1.64	2.31	4.62	0.19
MnO	3.10	3.80	3.65	0.021
CaO	8.52	3.58	7.77	7.53
MgO		1.32	0.51	1.63
Na_2O	16.74	13.85	15.13	17.87
K_2O		0.41	0.81	0.79
SO_3	—	0.42	0.45	0.24

†Colored by the addition of 4.5 lbs. of coal and 1.1 lbs. of sulphur to 1000 lbs. of sand.

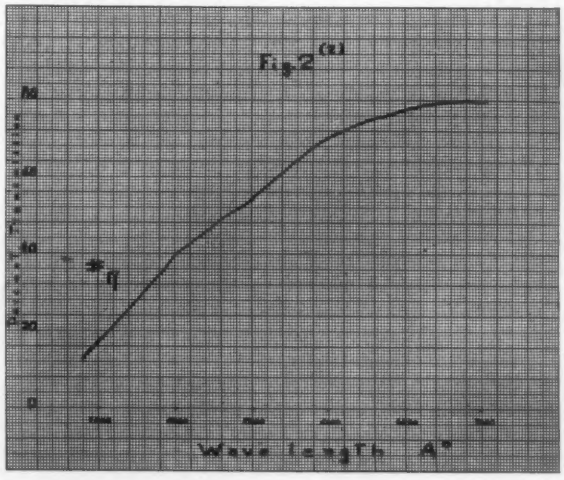
	—DESCRIPTION—		*Overall*
Glass No.	*Color*	*Thickness*	*Transmission*
16	Light amber	2 mm.	59.8%
17	Light amber	2 mm.	57.5%
18	Black amber	2 mm.	26.6%
21	Amber	2 mm.	42.4%

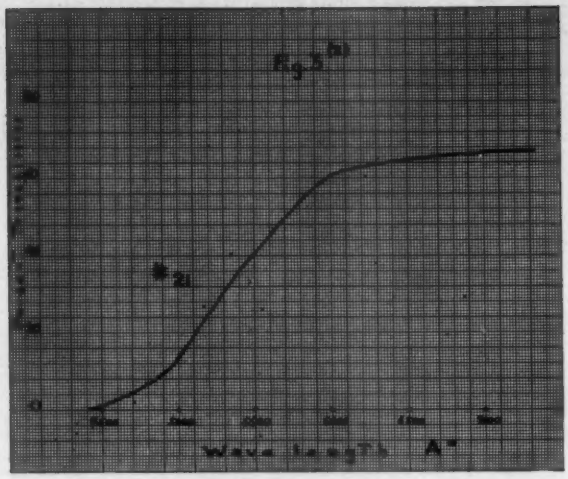
In Fig. 1 the two iron-manganese oxide glasses having the higher soda content are plotted together as the shape of their curves are very similar. While the transmission in the ultra-violet region (roughly that region below 4000 Angstroms) was not measured the general shape of the curve indicates that glass No. 16 may transmit in this region or at least must have a cutoff very close to



4000 Å. In any case there is an appreciable transmission in the region below 5000 Å, this region being considered by some as being very active photochemically and should be absorbed by the glass if the pharmaceutical is to be protected. Glass No. 18 does not seem to transmit much beyond 4500 Å. At 5000 Å it transmits about 20 per cent dropping rapidly to a few per cent at 4500 Å, thus making it a very good (but not perfect) protective glass for this active region. The one disadvantage of this glass from a container viewpoint is its low over-all light transmission, namely 26.6 per cent, it being so low that the glass is described as being black in color. If visibility of the contents in the container is not important such a glass may prove useful but better results can be obtained by using a completely opaque black glass which will eliminate all of the light.

Glass No. 17, shown in Fig. 2, is in general, as far as the region below 5000 Å is concerned, similar to glass No. 16 —and would offer no greater protection. In the region above 5000 Å the slope of the curve is quite different from that of glass No. 16. This difference may





be due in part to the differences in the iron oxide-manganese oxide ratios. The carbon-sulphur glass No. 21 is shown in Fig. 3. From the curve it can be seen that it closely resembles the black iron oxide-manganese oxide glass No. 18 in general form. The total transmission between 4500 and 5000 Å is somewhat less however and it would probably offer slightly better protection than glass No. 18. In addition its higher overall transmission, namely 42.4 per cent, and its amber color makes it a better glass from a container viewpoint.

This comparison between the light transmission of the iron-oxide-manganese oxide amber glasses and the carbon-sulphur amber glasses indicates that the former offer no advantages as far as light protection is concerned. In addition, as noted by Holland and Turner, far smaller amounts of coloring materials which produce the amber color are required in the case of the carbon-sulphur ambers.

[1]Jour. Soc. of Glass Tech., 1941, 25, 109. 164-220.
[2]Replotted from Holland and Turner's original curves, 20° C data used.

BULB SUIT AGAIN DEFERRED

At the re-opening in Trenton, New Jersey, of the Government's monopoly suit against leading firms in the electric light bulb industry, Samuel S. Isseks, special assistant to the attorney general, announced that the suit would be suspended until fall pending the marking of 1300 documents which the Government planned to present. Officials of the War and Navy Departments will confer with Attorney General Biddle during the summer on whether the continuance of the suit will impede the nation's war effort. If no delay is to be allowed the trial will be resumed on or about November 1st.

GLASS IN WAR PLANT DESIGN

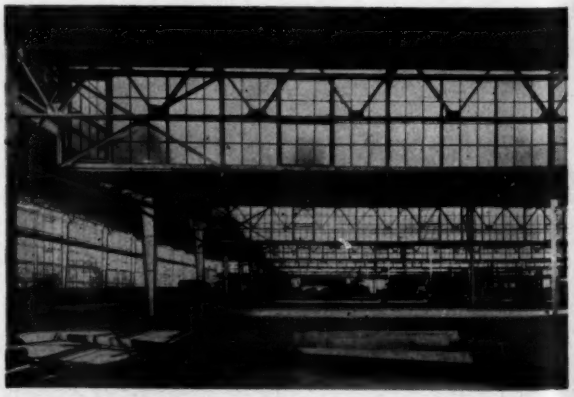
Glass is an important element in the building and planning of industrial plants in England. This fact was brought out by C. Howard Crane, designer of aircraft, munitions, steel and other types of plants for the British government, in discussing construction problems with a group of American architects.

Mr. Crane revealed that few windowless plants are being built. Their construction and operation are costly. Air ducts, fans and other mechanical equipment requiring metals are more urgently needed elsewhere. Steel sashes are being widely used and the sash areas so made that they can be quickly enlarged. Temporarily, about one-third of the sash area is being glazed, the remainder of the panes being filled in with asbestos so that after the war these panels can be removed and glazed. Natural daylight and air are being utilized as much as possible. For black-outs, fixed sash wall areas are painted black. Windows, to assure ventilation and light, are provided with black curtains. During air-raids the curtains overlap the painted sash area six to eight inches around the windows.

New factories are designed with blast walls and most older factories are now equipped with them. These walls usually are 14-inch, reinforced brickwork built 8 feet high to enclose every 10,000 square feet of working area, thus providing a series of enclosures which protect both workmen and machinery, serving at the same time to localize the effect of bombs. Above the 8 foot height regular steel sash is used.

A Service Box which has proved highly successful for production line floors in aircaft plants was descibed by Mr. Crane and it was his opinion that it might well be incorporated in American plants. The box is usually two feet square and built in four sections, flush to the floor, with a manually operated door in each section. One compartment has a coil of power line for attaching to an electric drill. Another section has a compressed air attachment. The third section has a portable coil for a small electric light, and the fourth is glazed with a diffusing type of glass. Underneath is a fixed light for illuminating the under side of the wing. When a plane being assembled reaches the point where work is required on underside surfaces, these service boxes, located about every 10 feet along the production lines, speed up work remarkably well.

Mr. Crane expressed his belief that there is a trend toward the type of building which will be best under all circumstances: a modern skeleton frame, either steel or concrete, with great windowed areas, some with special glasses to reduce glare and absorb sun-ray heat. Concludes Mr. Crane, "We now really appreciate the desirability of thin walls, consisting of structural and other glasses or some other thin material. Such walls can be combinations of transparent glass, of translucent and opaque glass, and while war is a horrible thing it should serve to create a world of beautiful, completely utilitarian types of buildings everywhere."



Assembly area of an airplant "somewhere in England"

FOAM GLASS

Part I of a Series of Articles on the Development and Uses of Foam Glass

By E. L. KREIDL

The development of glasses of foamy or cellular structure is of fairly recent date although the technical difficulty of producing them appears to be not greater than has been encountered in the production of other foam products. However, recognition of the fact that glass is a most desirable material for constructional purposes is only of recent date too and so we find that the development of hollow glass blocks and foam glass became of general interest at about the same time. In this connection it is interesting to note that cellular or foamy slag materials have preceded the development of foam glasses for quite some time. Foam slags mostly were used as light weight additions to concrete and cement and, accordingly, did not stimulate the development of similar products made from more expensive materials. The present urgent demand for inexpensive, non-flammable heat and sound insulating materials has greatly increased the interest in this product and production on a much larger scale than ever expected may be foreseen for the near future. As is so often the case, it may be assumed that once this new material has found extended application, new uses and improvements will be found and it will be here to stay.

Although only few of the methods developed for the manufacture of foam glass have found practical application the increasing interest in this new material should make it interesting to give a brief survey of the various methods described in literature and to discuss the principles underlying these methods.

A cellular or foamy material consists of a continuous network of walls which envelop completely isolated vesicles which may be filled with gases or vapors or which may be partially or totally evacuated. Common usage, unfortunately, has been apt to make no clear distinction between such a cellular structure and a spongelike structure. It is true, that for some purposes, especially where only density is to be considered, spongelike and cellular materials may be used interchangeably. With respect to most other physical properties, such as sound and heat insulation, but also with respect to their manufacture these two types of materials will be principally different. This difference is quite obvious since in a spongelike material the walls form an open spaced network so that both the solid and the gaseous phase of the material are continuous throughout the material.

The classic example—as well as the most commonplace—for the production of foam is the beating of egg white. Repeatedly this method was imitated for the production of industrial foamlike materials, such as in the production of cellular rubber from latex. Another example for the formation of foam is the foam on top of a glass of beer. In this case the foam is formed by the release of carbon dioxide which in the bottle or keg had been dissolved under pressure. A third example also may be taken from the kitchen, namely the rising of a leavened dough or of a dough to which a baking powder has been added. This last case also may illustrate the case where the above emphasized difference between a foam and a sponge structure is blurred. We all know that a baked dough is rather of a sponge character—we just have to think of a sponge cake—than of a foam character. This is due to the fact that the walls of the dough are not sufficiently resistant to withstand the gas pressure at the baking heat. Accordingly, the originally formed cells will burst and convert the foam structure into a sponge structure.

Practically all known methods for making foam or cellular materials may be traced back to these three commonplace methods. Inventiveness only had to supply the engineering and chemical skill to adapt them to the materials they are to be used for.

Properties of Foam Glass

The problems encountered in the preparation of foam glass and the evaluation of the various methods suggested for this purpose will be more readily appreciated if we first have a look at the finished product and find out what properties will be most desirable for its various applications. The principal idea underlying the development of foam glass was to obtain a lightweight material of good sound and heat insulating properties which due to its inorganic character would be non-flammable and due to its rigidity would be readily applicable for a variety of constructional purposes.

The physical properties of a foam glass will largely depend on the size, number and distribution of the vesicles in the glass. The smaller the individual vesicles the less will be their effect on the overall physical properties of the glass. Small gas bubbles of a size comparable to the wave length of light, if present in a sufficiently great number, will cause reflection, refraction and diffraction of light and thus cause opacity but will not affect the mechanical strength, sound and heat insulating properties of a glass. This fact has made possible the development of the gas opacification process by I. Kreidl for porcelain enamels where finely distributed gas bubbles of controlled size and distribution are formed on firing of the enamel without affecting its mechanical strength. Increase in bubble size and number will markedly decrease the surface strength of the glass or enamel and the undesirable effect of such relatively larger bubbles is a well known defect in all types of enamels. The sound and heat insulating properties of a glass will become noticeable only when the size and number of the bubbles is so greatly increased that the apparent density of the glass will be materially reduced. This fact again can be well illustrated by a heat insulating enamel which has been developed by Turk.[12] Turk found that to obtain an enamel of appreciable heat insulating property it should be so bloated by gas bubbles that its thickness is at least twice that of the unbloated enamel coat and its apparent density at least half of that of he corresponding unbloated enamel.

In a foam glass good "all around" properties will be obtained with a pore size of about .5 to 5 mm. if the wall size is relatively thin with respect to the pore

(*Continued on page* 278)

INVENTIONS AND INVENTORS

A Summary of United States Patents of Interest to the Glass Industry Issued During May

Compositions:

A yellow or amber tinted glass, the color of which is substantially insensitive to variations in melting and annealing conditions and which is particularly adapted for melting in continuous tank furnaces, is described in patent 2,282,601. The inventors, Henry H. Blau and Weston H. Gillett assigned the patent to Corning Glass Works. The color is produced by a small percentage of nickel, which however requires that zinc be present. In the following examples, composition A is an opal zinc glass having an ivory tint, B is a pale yellow or amber transparent glass and C, which contains uranium, is ivory colored.

	A	B	C
SiO_2 (silica)	60.1%	68.3%	59.8%
Na_2O (sodium oxide)	8.8	9.5	9.2
Al_2O_3 (alumina)	9.7	3.0	10.1
ZnO (zinc oxide)	12.3	14.1	14.4
CaO (lime)	4.8	—	4.3
PbO (lead oxide)	2.7	3.1	2.2
B_2O_3 (boric oxide)	1.6	1.9	—
Ni_2O_3 (nickel oxide)	.014	.015	.012
F (fluorine)	6.3	—	5.3
UO_3 (uranium oxide)	—	—	.04

Magdalene Hüniger of Berlin-Charlottenburg, and Hans Panke of Berlin received patent 2,284,055 (General Electric Co.) for phosphate glass compositions containing up to 25 per cent manganese oxide and up to 15 per cent cerium oxide to yield red, orange or yellow luminescent glasses. For mercury vapor discharge lamps these glasses are said to transform short wave radiation into rays of longer wave length.

Patent 2,282,540, assigned by Alden J. Deyrup of Westfield, N. J., to E. I. du Pont de Nemours & Co., concerns a low temperature vitrifiable flux for decorating glass ware, composed typically of 21 to 32.5 per cent lead oxide, 30 to 41.5 per cent zinc oxide, 21 per cent boric oxide, 8.5 per cent silica, 2.5 per cent sodium oxide, 4.0 per cent cadmium oxide and 1.5 per cent titanium oxide.

Furnaces:

Last month's GLASS INDUSTRY contained a discussion and drawing of Joseph H. Redshaw's method of feeding glass batch onto the bath in a thin layer which extends across the width of the tank. Further development of this Pittsburgh Plate Glass Co. equipment is disclosed in additional patents 2,284,398 to Karl G. Kutchka and 2,284,420 to Howard L. Halbach, Walter G. Koupal, and Wm. Owen. In the Kutchka invention of Fig. 1, two superimposed layers of material are fed to the tank. The lower layer is cullet which serves as a merging medium between the bath and the upper layer of raw batch material. As in the Redshaw apparatus the materials are advanced into the furnace by the swinging motion of the bottom plate on the raw material feed pipes. Patent 2,284,420 provides a low flat arch over the blanket of glass batch and under which the upper surface becomes fritted before it is moved into the melting zone.

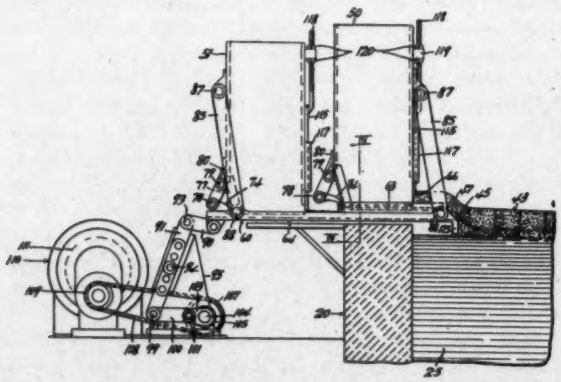


Fig. 1. 2,284,398: Kutchka. In charging multiple layers of batch to a glass tank, cullet is fed from the left bin and raw components from the right.

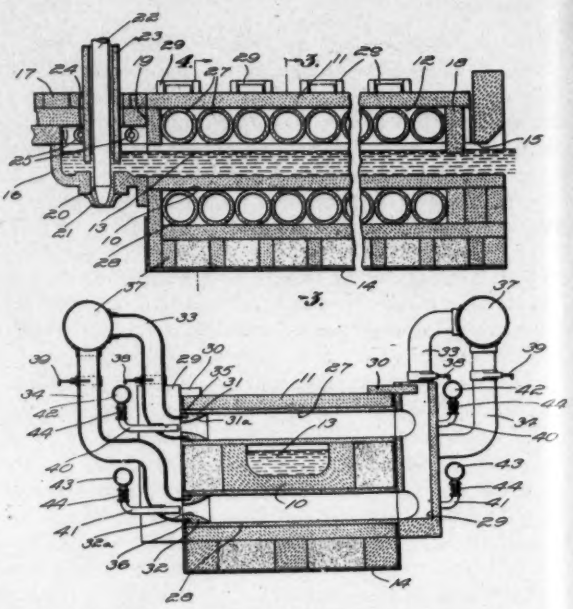


Fig. 2. 2,282,554: Barker. Tubular conduits above and below the glass provide for the establishment of uniform forehearth temperature by circulating heating and cooling gases.

In another of his electric heating patents John Ferguson of Cleveland immerses an electrode in the glass in a forehearth at a position just above the gob withdrawal point. An expected problem would be the overheating of the electrode due to poor heat dissipation. This is solved by building the electrode as a metallic shell of chrome-iron alloy and filling it with a metal of low melting point such as lead or tin which can circulate to an upper section of the shell outside the bath to dissipate the heat. This is patent 2,283,800.

Another patent for electric heating, this time applied both to the melting and refining operations in a tank furnace, is 2,283,188 granted to Anders E.A.S. Cornelius of Stockholm, Sweden, and assigned to Hartford Empire Co. The furnace is of the type which provides a submerged throat in the bridgewall separating the melting and refining chambers. The invention consists in increas-

ing the electrical density in a vertical zone adjacent to both sides of the bridgewall so as to produce convection currents counter to the out-surge through the throat, and in this way to recirculate any incompletely melted materials.

Fig. 2 illustrates the apparatus described by Wm. T. Barker, Jr., of West Hartford, Conn. (Hartford Empire Co.), in patent 2,282,554 for controlling forehearth temperatures. An object was to provide regulable temperature control without subjecting the molten glass to the direct action of flames or combustion products. He provides a series of parallel tubular conduits not only above the glass, but also under it, in the hearth. The tubes may be made of silicon carbide or any other suitable refractory material having high heat conductivity. A heating medium or a cooling medium may be passed through them, and since they possess individual valves, zone control is provided.

The heating or cooling medium is supplied from a common supply pipe 37 through pipes leading to the upper and lower banks of tubes. Each pair of upper and lower tubes communicates with a stack 29 for the exhaust of gases. Adjacent pairs have their intake and exhaust ends reversed so that only half of the stacks are on each side of the furnace. Each of the tubes 27 and 28 also is provided with a separate means for heating, consisting of fuel burners 40,41. Innumerable combinations are possible but in general the result sought is the establishment of a predetermined temperature uniformly throughout the entire cross-section of the stream of glass in the forehearth channel by the time the glass reaches the feed bowl or spout for delivery of the charge.

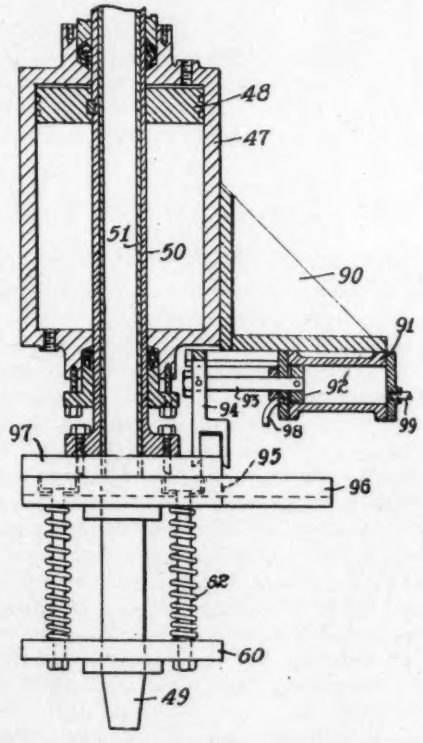


Fig. 3. 2,282,449: Bert. Plunger 49 used for pressing glassware slides to the right on slide-way 96 so that a charge can be delivered to the mold through the hollow piston rod 50.

Feeding, Forming and Shaping:

An opening and closing mechanism to operate molds in the continuous production of bottles, light bulbs, tumblers, etc., is detailed in patent 2,283,055 issued to David E. Gray and Leander N. Pond of Corning, and Walter C. Weber of West Hartford, Conn. This Corning Glass patent was divided from another patent application which no doubt will give a clearer idea of the utility of the mechanism.

Jakob Dichter of Berlin-Schoneberg, Germany, received patent 2,282,993 for a method of making ampoules.

The apparatus of patent 2,284,089 which was granted to Clarence E. Hahn and John Salo of Cleveland (General Electric Co.) is intended to reduce the diameter of the two ends of glass tubes to adapt them for tubular incandescent lamps.

Walter K. Berthold's patent 2,282,848 (Hartford-Empire) relates to improvements in the Karl Peiler process of introducing steam into bottles after they are shaped in a machine of the Hartford I.S. type. Berthold has found that the chemical durability of the glass articles which have been blown and then cooled by steam may be increased by scavening the moisture that otherwise would remain as a residue from the steam. The steam improves chemical durability if left for a short time but it is reported that the residual moisture has a deleterious effect if left too long. Berthold's equipment provides means of removing this moisture by dry air injection after the bottle leaves the forming machine.

Two forming machine patents 2,284,508 and 2,282,449 were issued to Samuel D. Bert of Washington, Pa., who assigned thirds to Maurice A. Yorkin and James D. Martin, also of Washington. The first of these relates to control of the driving mechanism for machines of the press and blow type so that the speed is decreased at the time of station pauses in the mold carrier movement. The other patent presents some novel ideas with regard to charging the molds of a machine making pressed glassware. Fig. 3 shows a pressing plunger 49 in place for shaping the ware by air pressure applied through piston rod 50. When the plunger withdraws from the mold it is automatically slid to the right along slideway 96 so that it is no longer in alignment with the piston rod 50. The latter rod which is hollow then serves as the delivery tube for feeding the next charge of glass to the mold.

Sheet and Plate Glass:

Patent 2,282,440 granted to Joseph F. Turke of Collins, N. Y., describes an electrical glass splitting machine for making curved or straight cuts. Novel details are the means of supporting the glass under the heating elements and the pressure apparatus for holding it against the glass. A manual cutter is disclosed in patent 2,283,134 which issue to Richard C. Barrett of Bristol, Conn.

Andrew H. Stewart of Shields, Pa., in patent 2,283,705 outlines a flow sheet for manufacturing a glass faced building tile to which a metal mounting element is permanently attached by welding it to the glass by means of sprayed metal. The unit is put together before the

glass has cooled from forming. Sprayed molten metal from a metallizing gun is also used by Charles D. Haven of Toledo (Libbey-Owens-Ford Glass Co.) in patent 2,283,253 for bonding a metal spacer plate to the two glass sheets of a multiple thickness glazing unit. The essence of his invention concerns means of directing the metal mist to avoid droplets falling on parts of the glass where they are not wanted.

Metal fittings for supporting tempered glass doors are described in patent 2,284,409 issued to George F. Erath of Queens Village, N. Y. (Pittsburgh Corning Corp.).

Patent 2,284,348 to Forest S. Tharp of Clarksburg, W. Va. (Pittsburgh Plate Glass) is concerned with the design of cooler units on each side of a vertically drawn glass sheet, just above the meniscus.

In the process of laminating glass by flowing a liquid strengthening material onto pairs of cut sheets, the excess liquid flowing over the edges of the sheets gums up the slat-type conveyors and represents a considerable loss of expensive material. In patent 2,282,399 Patrick Finnegan of Jeannette, Pa. (Pittsburgh Plate Glass) substitutes the roll conveyor of Fig. 4 and provides a collecting roll 60 which gathers the excess liquid. It is collected in trough 80 and returned to the supply reservoir. The collecting process is aided by driving the rolls at a faster rate than the rolls of the conveyor. This draws out the liquid sufficiently to prevent an excess on the glass sheet at its edges.

There are a number of special problems encountered in grinding the small plates from which automobile rearview mirrors are made. Grinding apparatus which holds a multiple number of these blanks is described in patent 2,283,289 assigned to Libbey-Owens-Ford Glass Co. by George R. Roesch and Gerald White of Toledo.

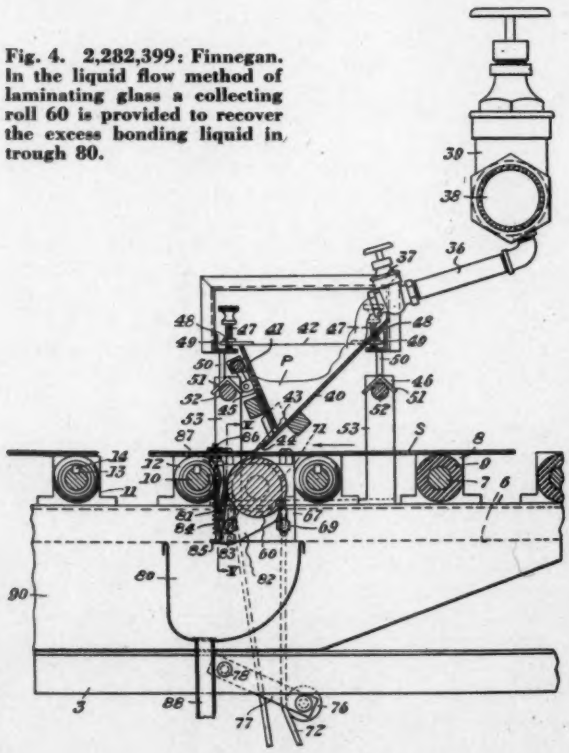
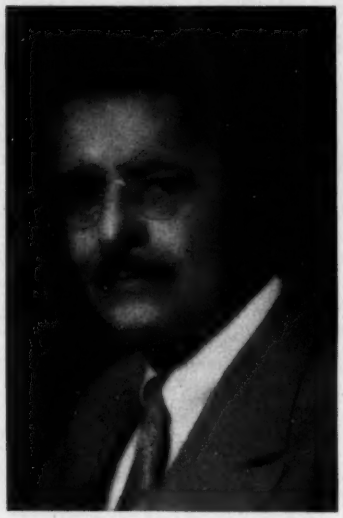


Fig. 4. 2,282,399: Finnegan. In the liquid flow method of laminating glass a collecting roll 60 is provided to recover the excess bonding liquid in trough 80.

WILLIAM L. MONRO, JR.

William L. Monro, Jr., executive vice president of the American Window Glass Company, died on June 10th after an illness of several months.

Mr. Monro first entered the glass manufacturing business in 1919 at the Belle Vernon plant of the American Window Glass Company. During the next few years he



worked in several plants and made three trips to Europe to study glass making methods. Mr. Monro was made assistant to the president of the American Window Glass Company, his father, in 1925, became superintendent of factories in 1929, and four years later executive vice president.

A graduate of Harvard University in 1916, Mr. Monro served with the AEF, the Army of Occupation in Germany, and was a member of President Wilson's guard in Paris.

BAUSCH MUSEUM DEDICATED

An ox yoke and a Benares silver tea set formed the nucleus for a museum now celebrating its 27th year by moving into a new $521,000 building. The new Bausch Hall of Science and History, dedicated to the people of Rochester in the presence of a notable gathering of celebrities, is the gift of Edward Bausch, scientist and industrialist.

The new building is constructed of Indiana limestone and consists of 3 main floors, mezzanine and basement. A heating and air conditioning plant housed in the penthouse warms, washes, and eliminates dust from the air and is capable of changing the entire atmospheric contents of the building in five minutes. In addition to the exhibit rooms and halls a research laboratory, auditorium, photographic studio, star garden for astronomical work, workshops, print shop and kitchen are included.

An interesting feature of the dedication ceremonies was the unveiling of a bronze bust of Dr. Bausch by the internationally renowned sculptress, Guitou Knoop. The bust is a gift of Bausch & Lomb employees.

ROSS PURDY ACCORDED HONORARY MEMBERSHIP IN AMERICAN CERAMIC SOCIETY

At the 44th annual meeting of the American Ceramic Society in Cincinnati, Ross Coffin Purdy, ceramic leader and General Secretary of the Society, was presented by President J. T. Littleton with a diploma of Honorary Membership. In added tribute a portrait bust of Dr. Purdy was presented to the Society, the gift of the sculptor and Dean of American Glass Men, Frederick Carder. In accepting the gift the hope was expressed that the

Bust of Ross C. Purdy made by Frederick Carder

plaster model will be replaced by one in glass as a fitting material in which to perpetuate the memory of a pioneer in American ceramics.

A thoroughly loyal American, Dr. Purdy has at all times insisted on first consideration for Americans and their products. His contributions to the growth and usefulness of the American Ceramic Society as its General Secretary and the inspiration he has been to his associates will reach far into the future of the ceramic world.

Ross Coffin Purdy was born March 3, 1875 in Jasper, N. Y. He received a public school education and entered Syracuse University in 1896. Two years later, upon learning of the first four-year course to be offered in ceramics, he transferred to Ohio State University. Only six weeks later, however, the death of his father necessitated his changing to a two-year industrial course from which he graduated in 1898, continuing his studies on a competitive scholarship for another year. He joined the Mosaic Tile Company, Zanesville, Ohio, as chemist and assistant superintendent for two years. The following year he had a similar position with the Roseville Pottery. At the Buckeye Pottery Company in Macomb, Illinois, producers of stoneware specialties, he developed various colored glazes and assisted in sales. And so began the career of a man who has unstintingly devoted his life to the cause of ceramics and distinguished himself as its outstanding leader.

In 1902 General Edward Orton, Jr., Director of the Department of Ceramic Engineering at Ohio State University, invited Dr. Purdy to become instructor, which position he accepted and retained until the fall of 1905 when he was made assistant professor of ceramics at the University of Illinois. Here he organized and equipped the Department of Ceramics and also served as ceramist with the Illinois Geological Survey, publishing a number of bulletins on fritted and crystalline glazes and on the pyro-chemical and physical behavior of clays. He returned to Ohio State University in 1907 as an assistant professor and in 1911 was appointed full professor. In 1912 Dr. Purdy resigned his professorship to become director of laboratory research for the Norton Company of Worcester, Mass., manufacturers of abrasives. Upon leaving the Norton Company in 1919, he engaged in private consultation as ceramic engineer.

The American Ceramic Society was founded in 1898, and it was in 1922 that Dr. Purdy was made General Secretary. It was Ross Purdy's idea that industrialists as well as educators and research men should be cared for by The Society. It was also he who as far back as 1918 was responsible for the creation of Industrial Divisions with separate programs at Annual Meetings. Local sections and student branches were created in a number of the universities. In this way The Society was strengthened by avoiding the breaking up of groups to form individual societies. It was also through the influence of Dr. Purdy that federal bureaus developed an interest in ceramics and established government divisions. His influence was felt not only in this country but abroad where he has insured contacts with many societies and industrial groups. His personally conducted tour of Europe in 1928 with a group of seventy members of the Society was a memorable occasion, rich in pleasure to all as in the fullfilment of their purpose.

Dr. Purdy is affiliated with the American Society for Testing Materials and the American Association for the Advancement of Science (Fellow). He is an Honorary Member of the Canadian Ceramic Society and of the Czechoslovak Ceramic Society, and an Honorary Fellow of the Society of Glass Technology of England. He is also an Honorary Life Member of the Ohio Ceramic Industries Association and was granted the honorary degree of Doctor of Science by Alfred University.

In an article, "Twenty Years of a Great Man's Life," V. V. Kelsey aptly describes Dr. Purdy:

"He has the knack of power in accomplishing worthwhile things. . . . He is a noble, rugged individualist. His qualities are mixed in a manner which make him outstanding. Those who know him recognize his fine qualities as coming from his noble responses to his place in life. His high sense of duty never permits him to falter in his complete faithfulness. . . . His high concept for his professional duties has led him to undertake and accomplish greater tasks than most individuals. In his relation with others, he is at home with all men, superiors, equals, and subordinates. He seems to get a quiet joy out of serving others."

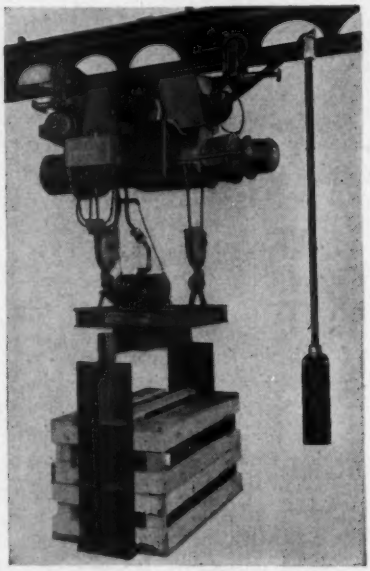
NEW EQUIPMENT AND SUPPLIES

CRATE GRAB AND CARRIER

A motor-driven crate grab and carrier has been developed by The Cleveland Tramrail Division of The Cleveland Crane & Engineering Company making possible quick stacking at a great height with safety. Operations are controlled by six buttons of the push-button station. If desired the unit can be provided with an operator's cab in which all controls may be located.

The arms of the grab are extended and retracted by means of geared slide bars driven by the motor mounted on top of the grab, the power for the motor being supplied through a flexible cable held taut by a spring-type retrieving reel. A double-hook cable type electric hoist elevates and lowers the grab with very little swing, making it easy to spot. A quick acting electric brake stops and holds the load wherever desired.

The unit illustrated will lift loads up to 1500 lbs. a distance of 20 feet. The arms may be spread to a maximum of 36 inches and a minimum of 18 inches. One or more boxes can be handled at a time.



VARIABLE SPEED TRANSMISSION

A special design of the Reeves Variable Speed Transmission is now offered by the Reeves Pulley Company. The new model is equipped with built-in chain reducer, and with the output shaft in exact alignment with the input shaft. Output speeds may be increased or decreased as compared to the variable speed shaft of the transmission, and infinitely variable, within predetermined limits, by turning the speed control handwheel. The chain drive operates in a bath of oil.

NEW TYPE PACKING MATERIAL

Entirely new and revolutionary in type is a resilient packing material made of kraft stock by the Research Products Corp. of Madison, Wisconsin. The material is expanded into a honeycomb pattern, by an exclusive patented process, and thereby a third dimension is obtained which gives the new product its unusual cushioning properties. It is known as Research Shipping Pack and is claimed to conform to double curvature surfaces achieving a streamlined effect. Because of its lacy openness the article within is partially revealed. It is light in weight, flexible and easy to handle. Offered in rolls and pads.

SEMI-AUTOMATIC CONTOUR MACHINE

Control equipment known as the Duplimatic, manufactured by the Detroit Universal Duplicator Company, permits contour machining with standard machine tools at speeds and accuracies beyond the operation of human operation. The equipment is installed in one of the major aircraft war plants, controlling the milling of aircraft connecting rods.

Manipulation of feed screws is in accordance with the outline of a template mounted on the table with the work. An immovable tracer mechanism mounted on the head of the mill is connected with the control so that the Duplimatic moves the table with the template always touching the tracer finger with a predetermined and exact amount of pressure. The template is held constant regardless of its shape or the speed of cutting feed. Equipment is portable.

FAST STABILIZING CONTROL

For application where process-lag is considered a development known as Hyper-Set has been announced by the Foxboro Company. It is a control function, available in the newly designed Model 30 Stabilog Controller, and reduces the effects of a process disturbance by making initial temporary additional corrections proportional to the rates of change of the measured value caused by the disturbance. The normal reset follows, establishing stabilization, but the several control functions are simultaneously and automatically adjusted. Tests with Hyper-Reset consistently re-established process stabilization, following an upset, in one-quarter of the time and with only one half the upset effect as compared with a similar controller having the usual reset.

PORTABLE SERVICE STATIONS

Planned expressly for the lubrication of war production machinery, particularly in plants working at maximum capacity where maintenance time is reduced to a minimum, the Alemite Division of Stewart-Warner Corporation announce three portable service stations. Ease of operation is an outstanding feature. Each unit can be handled by one man or several operators can work simultaneously from the same unit. Standard and advance models are supplied with air compressor, or with air hose mounted on reel for quick connection to plant air line. Units are also equipped with shelves, racks, drawers for tools, waste, etc.

CATALOGS RECEIVED

Cambridge Wire Cloth Co., Cambridge, Md. Bulletin 77 illustrates and describes various baskets and crates for annealing, pickling and washing purposes.

Wheelco Instruments Co., Chicago, Illinois. Bulletin Z600 gives a condensed listing of the complete Wheelco line of measuring and control instruments. Describes and illustrates unit construction of temperature controllers. Other instruments also covered.

B. F. Goodrich Co., Akron, O. Pamphlets, on "Rubber Hose" and "Mats and Matting" complete a series of six on the subject, "How to get the most out of Industrial Rubber Products." Practical for use among foremen and maintenance men.

Foxboro Company, Foxboro, Mass. Bulletin A-264, just issued, describes and illustrates instruments for automatic measurement and recording of densities of process liquids. Auxiliary equipment for installation is also shown.

CATALOG & BULLETIN SERVICE

Current catalogs and manufacturers' service bulletins reviewed in this department may be obtained by writing to THE GLASS INDUSTRY.

Research Digest

Practical Interpretations of Glass Technology

An Investigation of the Decay of Vibration Phenomena of Glass Bars

Evaluating the quality of a goblet by striking it and discovering how pleasant and lasting a "ring" might be produced would horrify a hostess at any formal dinner. Salesmen use this property as a musical accompaniment to a sales talk, and as a demonstration that the stemware is "genuine lead glass, made in a pot." If the real quality of the piece does not stand out because of its brilliant surface, artistic design, and excellence of etching or cutting, all the sonorousness of a bronze bell cannot save it.

Mr. McCann has made a scientific study of the phenomenon of "ring," using modern equipment to obtain a timed record of the duration (or decay) of vibrations. He demonstrated the influence of size and shape on this property, and also the influence of increasing lead content. However, he failed to take into account the more important influence of potash.

When potash was not available during the first World War, American stemware was made with soda. The "ring" was very poor, but the ware was still beautiful. On the other hand, Bohemian crystal, in many lovely patterns, has been made without lead, but with potash enough so that its tone would satisfy any amateur, wet-fingered Swiss bell-ringer.

Perhaps some coordination can be found between the elastic modulus of the glass and its "ring." Borosilicate beakers ring very well, and the glass consists largely of silica and boron oxide, both of which are given small factors for Young's modulus, by the Jena investigators. Disannealing, which increases the rigidity—essentially, the elastic modulus—of the glass, results, as McCann points out, in impaired tone. There must be an optimum value of elasticity, or else lead should be a good metal for bells.

The Effect of Tin on Gold-Ruby Glass

Veazie and Weyl have made a very interesting discovery, which goes far toward explaining why tin oxide is almost always included in batches for gold- and copper-ruby glasses. Here is a specific reagent, whose presence seems to promote that complete solubility of the free metal in the glass which is an essential prelude to its separation in particles of colloidal size to produce color.

This discovery seems remarkable, in view of the comparative insolubility of tin oxide itself, which leads to its use as an opacifier in glasses and enamels. Somehow, by the ancient but effective method of trying everything, this use of tin oxide was found out long ago. Now come x-ray study and modern notions of atomic arrangement, to explain why these things be.

The Vagaries of Glass in Its Annealing Range

One of the papers presented at the Cincinnati meeting which has appeared in print only in the form of a rather complete abstract (*Glass Industry*, May, 1942, page 179), is by Dr. Arthur Q. Tool and is entitled, "An Analytical Representation Concerning Glass in Its Annealing Range."

Most of us feel inclined to turn the page quickly when we see the formidable mathematical treatment, but this paper is probably one of far-reaching importance in the scientific study of the behavior of glass. It will be recalled that Tool and his associates at the National Bureau of Standards have been working for many years on the peculiarities exhibited by glass at temperatures between its so-called transition point and its softening temperature. In particular, the properties studied have been the expansibility and the density, together with certain endothermic and exothermic effects which have been safely demonstrated.

The immediate utility of work of this kind may not be easy to discover. However, these patient studies have brought out the important fact that glass of a given composition will not always be the same in the cold, and, in particular, it will not, by any means, have the same behavior as it is being heated up to and through its annealing range regardless of previous heat treatment.

That is to say, the so-called physical constants of a given glass are not constants at all in the strict sense of the word, unless the glass has been annealed always at the same temperature and cooling rate. Therefore, if the manufacturer expects to have completely constant behavior in his product, he must accept such work as this as furnishing another admonition to pay strict attention to routine. For a great many products, and in glass for many ordinary uses, these differences in behavior will be too small to be of any consequence. On the other hand, it may be that many obscure cases of breakage and loss, either in the course of manufacture or in subsequent use, may be traced to the existence in the glass of some molecular adjustment, or rather the lack of molecular readjustment that had hitherto been unintentionally obtained.

Perhaps someday we may look to Dr. Tool for a much better exposition than this reviewer can give of the value of his researches to the practical glassmaker. In the meantime, we must continue to admire his advanced treatment of the crooked expansion curve and his exceedingly clever invention of the "fictive" temperature in the most satisfactory theory of behavior of heated glass that has thus far been advanced.

NEW PROCESS CROWN GLASS

Interest in Crown Glass has reappeared with a trend toward its use in architectural and decorative installations. A modern process yielding a product almost indistinguishable from genuine Old Crown Glass, made for window glazing up to a hundred years ago, has been developed by Chance Brothers, Ltd. The new method permits the making of pieces up to about 18 in. x 12 in. Previously the size was restricted to very small areas.

PRP REQUIRES CODE SYMBOLS ON PURCHASE ORDERS

In connection with the extension of the Production Requirements Plan to nearly all companies using more than $5,000 worth of basic metals in a quarter, the War Production Board has set up, by Priorities Regulation No. 10, an Allocations Classification System. Numerical code symbols as set up by the System must be used on all purchase orders placed after July 1, except those at the retail level; orders by an individual consumer or a retailer, therefore, do not need these symbols.

The System is described as "a simple, clear method of indicating the movement of materials in civilian and war production." They show both the end use and the ultimate purchaser of all products covered. They are intended to reduce the number of forms and reports that industry must now submit to the War Production Board and they will furnish vitally needed information to guide WPB in its allocation of materials.

The System is a combination of numerical symbols showing end use and of letters indicating the broad category in which the purchaser falls. There are five purchaser groups: The Army (USA); The Navy (USN); Lend-Lease (LL); other foreign purchasers (FP) and domestic purchasers (DP).

There are 23 end-use groups. Thus 1.00 covers Aircraft, Production and Maintenance; 7.00 includes War Facilities, Construction and/or Maintenance; 14.00 Industrial Food Processing: Within each group, the numbers after the decimal point describe the more definite type of equipment. Thus orders for material going into bombs for the Army Air Corps will use the symbols USA 5.30. The symbols will be used through the whole cycle of production from the smallest sub-contractor to the prime contractor rolling out the finished product.

Because of the fundamental changes which have been made in the whole priorities system, the WPB urges all businessmen to obtain copies of the orders putting them into effect: Priorities Regulations No. 10, 11, and No. 3 as amended. Specific questions should be directed to the nearest district office of the WPB.

The use of preference ratings will be simplified and standardized by the terms of an amendment to Priorities Regulation No. 3, issued June 12.

Effective July 1, any preference rating, no matter how it has been assigned, may be applied or extended by a single form of certification, which states merely that the purchased certifies to the seller and to the War Production Board that he is entitled to use the preference ratings indicated on his purchase order, in accordance with the terms of Priorities Regulation No. 3.

Provisions of existing orders which require a purchaser to furnish his supplier with copies of preference rating orders or other special certifications are all rescinded, except for the special provisions of Regulation No. 9 with respect to the application of preference ratings for certain types of exports. In addition to the standard certification, orders on which a preference rating is applied or extended after July 1 must also include the identification symbols required by Regulation No. 10, which established the Allocation Classification system.

The amended Regulation No. 3 restricts extension of preference ratings, in most cases, to material which will be delivered to, or physically incorporated in a product delivered to the person to whom the rating was originally assigned, or which will be used to replace in inventory materials so delivered, subject to definite limitations. A rating may not be extended to replace materials in inventory except to the extent necessary to restore the inventory to a practicable working minimum. No rating higher than A-1-b may be assigned to orders for replacement of materials in inventory, even though the order for which the materials were used may have carried a higher rating.

A "basketing" provision permits the simultaneous extension of ratings which have been assigned by different preference rating certificates or orders on a single purchase order. When ratings are basketed in this way, the lowest rating may be extended for the whole order, or the various items may be listed separately, with the corresponding rating applied to each.

Special provision is made for small manufacturers not operating under the Production Requirements Plan. Such producers may extend ratings to deliveries of operating supplies including lubricants, small perishable tools, etc., which are required and will be consumed in filling the rated order which they are extending, but the cost of such operating supplies must not exceed 10 per cent of the cost of the materials to which the rating is extended. Not more than 25 per cent of the supplies thus obtained during one month may be metals in the forms described in Metals List of Priorities Regulation No. 11.

FELSPAR A BOMB EXTINGUISHER

Ground felspar has been found highly effective as an extinguisher of incendiary bombs, as disclosed by the Geological Survey, of the Department of the Interior. Harold L. Ickes announced that steps were being taken to obtain a Government controlled patent for the protection of the public.

Sprinkled on a bomb, felspar quickly melts and forms a protective coating which cuts off the air supply and prevents burning. It is considered superior to mixtures containing salt, pitch ashes or fine powders. Much of the low grade felspar which is usually discarded is suitable for this purpose and it is estimated that the product could be sold for 50 to 75 cents a hundred pounds wholesale.

INTERNATIONAL NICKEL GIVES FELLOWSHIP AT MELLON INSTITUTE

An Industrial Fellowship has been established at the Mellon Institute of Industrial Research, Pittsburgh, Pa., by the International Nickel Company, Inc., New York City. The fellowship covers scientific research on certain problems in the chemistry and technology of nickel, with special emphasis on the preparation, properties, and uses of nickel compounds. The incumbent is Dr. John Gilbert Dean, a physico-organic chemist, Brown University (Ph.B., 1931; M.S., 1932), Columbia University (Ph.D., 1936), and who subsequently has had five years of experience in applied chemical research.

CURRENT PRICES OF GLASS-MAKING MATERIALS

FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS

Base Materials

		Carlots	Less Carlots
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	....	....
Precipitated material		55.00	60.00
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk f. o b. shipping point	ton	15.00-16.00	18.00
Borax ($Na_2B_4O_7 10H_2O$)			
Granulated	In bulk, ton	42.50	....
Granulated	In bags, ton	46.00	57.00-62.00
Powdered	In bags, ton	51.00	62.00-67.00
Boric acid (H_3BO_3)			
Granulated	In bulk, ton	96.50	
Granulated	In bags, ton	100.00	112.00-117.00
Calcium phosphate ($Ca_3(PO_4)_2$)	lb.	.07	.07½
Cryolite ($Na_3Al\ F_6$) Natural Greenland (Kryolith)	lb.	.09½-.09¾	.10
Synthetic (Artificial)	lb.	No supplies available.	
Feldspar—(published list prices)			
20 mesh	ton	11.00-13.25	
40 mesh	ton	11.50-13.75	
Granular	ton	11.75-14.00	
Semi-granular	ton	11.00-13.25	
L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags.			
Fluorspar (CaF_2) domestic, ground, 96-98% (max. SiO_2, 2½%)			
Bulk, carloads, f. o. b. mines	ton	34.00	....
In bags	ton	36.40	50.00
Kryolith (see Cryolite)			
Lead Oxide (Pb_3O_4) (red lead) (N. Y.)	lb.	.0900	....
In 5 Ton lots	lb.	....	.0950
Less than 5 Tons	lb.	....	.10
Lime—			
Hydrated ($Ca(OH)_2$-MgO) (in paper sacks)	ton	8.50	8.50
Burnt (CaO-MgO) ground, in bulk	ton	7.50	....
Burnt, ground, in paper sacks	ton	9.50	9.50
Burnt, ground, in 280 lb. drums	Per drum	2.35	2.35
Kiln Dried ($CaCO_3$-$MgCO_3$) 10x30 mesh	ton	2.00	....
Kiln Dried ($CaCO_3$-$MgCO_3$) 16x20 mesh	ton	2.00	....
Nepheline Syenite, f. o. b. shipping point	In bulk, ton	12.00	15.00
Potassium carbonate—			
Calcined (K_2CO_3) 96-98%	lb.	.065	.0675
Hydrated 80-85%	lb.	.055	.0575
Salt cake, glassmakers (Na_2SO_4) in bags	ton	21.00-22.00	28.00-30.00
	in bulk	17.50	
Soda ash (Na_2CO_3) dense, 58%—			
Bulk	Flat Per 100 lb.	.95	....
In barrels	Per 100 lb.	1.35	....
In Paper bags	Per 100 lb.	1.10	
In Burlap bags	Per 100 lb.	1.15	....
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls. 95% and 97%	Per 100 lb.	....	3.00-3.40
Bulk	Per 100 lb.	1.35	3.60-4.00
200 lb. bags		1.4675	1.48
100 lb. bags		1.475	1.50

Special Materials

	Carlots	Less Carlots
Aluminum hydrate ($Al(OH)_3$) lb.	.031-.034	.045
Aluminum oxide (Al_2O_3)	.07	.09
Antimony oxide (Sb_2O_3) lb.	.15	.15½-.16½
Arsenic		
Glassmakers lb.	.04¼	.04⅝
Regular refined white lb.	.04	.04½
Arsenic trioxide (As_2O_3) (dense white) 99%		
In barrels	.04-.04¼	.04½-.04¾
Barium nitrate ($Ba(NO_3)_2$) lb.	....	Open price.
Pyrophyllite (20% Al_2O_3) ton	10.00	13.00
Sodium fluosilicate (Na_2SiF_6) lb.	.09	.12
Tin Oxide (SnO_2) in bbls. lb.	....	Open price.
Titanium Oxide (ceramic grade)		
In bags lb.	.14½	....
In barrels lb.	.14¾	....
Zinc Oxide (ZnO)		
American process, bags lb.	.07¼	.07½
White Seal, 150 lb. bbls. lb.	.09¾	.10
Green Seal, bags lb.	.09	.09¼
Domestic White Seal, bags lb.	.09½	.09¾
Red Seal, bags lb.	.08½	.08¾
Zircon		
Refined Granular (Milled .01-.02c higher)	.06½	.07-.08

Coloring Materials

	Carlots	Less Carlots
Barium selenite ($BaSeO_3$) lb.	....	1.40-1.60
(Commercial, 25% Selenium) lb.	....	.85
Cadmium sulphide (CdS) lb.	....	1.10-1.15
Cerium hydrate—		
100 lb. drums and 600 lb. barrels lb.	....	.65
Chrome Oxide Green, 400 lb. bbls. lb.	....	.25-.28
Chromite (99% through 200 mesh) ton	58.25	64.75
Chromite ore (air floated) ton	58.25	64.75
Cobalt oxide (Co_2O_3)		
In bbls. 350 lbs. or more, lb.	....	1.84
Less than 350 lbs., lb.	....	1.94
Copper oxide—		
Red (Cu_2O) lb.	....	.20-.22
Black (CuO) lb.	....	.19-.22½
Black prepared lb.	....	Open price.
Iron Oxide—		
Red (Fe_2O_3) lb.	....	.06½-.10
Black (Fe_3O_4) lb.	....	....
Iron Chromate lb.	....	.035-.05
Lead Chromate ($PbCrO_4$) in bbls. lb.	....	.16½
Lithium Carbonate lb.	....	1.25
Manganese, Black Oxide African		
In Paper bags ton	70.00	78.00
In Burlap bags ton	71.75	79.75
In Casks ton	74.00	82.00
Neodymium oxalate, 50 lb. drums lb.	....	4.00
Nickel oxide (Ni_2O_3), black lb.	....	.34-.40
Nickel monoxide (NiO), green lb.	....	.35-.37
Potassium bichromate ($K_2Cr_2O_7$)—		
Crystals and Granular lb.	.09½	.09¾-.10
Powdered lb.	....	.10¼-.10½
Potassium Chromate (K_2CrO_4) 100 lb. kegs. lb.	....	.27
Powder blue lb.	....	.21-.25
Rare earth hydrate—		
100 lb. drums lb.	....	.35
325 lb. barrels lb.	....	.30
Selenium (Se) in 100 lb. lots lb.	....	1.75
In lesser quantities lb.	....	1.85
Sodium bichromate ($Na_2Cr_2O_7$) lb.	.07¼	.07½-.07¾
Sodium chromate (Na_2CrO_7) Anhydrous lb.	.08⅝	.08⅞-.09¼
Sodium selenite (Na_2SeO_3) lb.	....	1.50-1.65
Sodium uranate (Na_2UO_4) Orange lb.	....	1.65
Yellow lb.	....	1.65
Sulphur (S)—		
Flowers, in bbls. Per 100 lb.	3.40	3.75-4.15
Flowers, in bags Per 100 lb.	3.05	3.40-3.80
Flour, heavy, in 250 lb. bags Per 100 lb.	2.95	3.30-3.70
Uranium oxide (UO_2) (black, 96% U_3O_8)		
100 lb. lots. Black lb.	....	2.55
Yellow orange lb.	....	1.65

Polishing Materials

	Carlots	Less Carlots
Emery, Turkish lb.	.075	.08
Pumice Stone,		
American Ground FFF, FF, F lb.	.03	.04
0, 0½, ½, 1 lb.	.05¾	.05¾
Putty Powder lb.	Open price.	
Rotten Stone (Domestic) lb.	.02¼	.03½
Rouge, Red lb.	.18	.16
Black lb.	.15	.18

CURRENT STATISTICAL POSITION OF GLASS

During May there was little change in activity in the glass industry as production continued at recent high levels; employment and payrolls were at a new high for this period of the year. According to THE GLASS INDUSTRY's Production Index, glass output during May amounted to approximately $43,000,000 as compared to $39,000,000 in last year's corresponding month. During the first five months of this year glass production was estimated at $210,000,000 as compared to $178,000,000 in last year's comparable period—an 18% increase.

Plate glass production during May amounted to 4,310,364 square feet according to the Plate Glass Manufacturers of America. This was the lowest output for this branch of the glass industry since May 1938, representing a decline of 23 per cent below April 1942 and 76 per cent below May 1941. During the first five months of this year plate glass production totalled 30,187,000 square feet—67 per cent under last year's level.

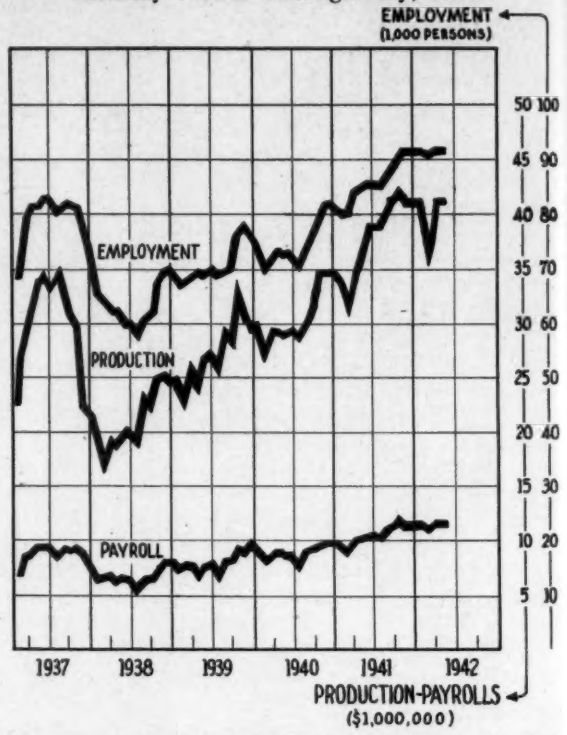
Window glass production during May dropped 5 per cent from the previous month's level to 1,557,135 boxes which represented 95.9 per cent of the industry's rated capacity. As compared with this, May 1941 production was 1,281,515 boxes, representing 78.9 per cent of the industry's rated capacity. During the first five months of 1942 this output was 7,879,000 boxes—a 10 per cent increase over last year's corresponding period.

Glass container production during May totalled 7,191,675 gross, according to the Glass Container Association of America. This all-time record represented a 5 per cent increase over the previous month and a gain of 15 per cent over May 1941. During the first five months of 1942 glass container production reached the record total of 33,771,453 gross which was an increase of 32 per cent over 1941.

Shipments of glass containers during May were reported at 6,996,813 gross, or 9 per cent more than last year's corresponding month. This trend was not prevalent in all lines, for pressure and non-pressure ware dropped 33 per cent, liquor ware 19 per cent, general purpose ware 3 per cent, milk bottles 5 per cent and domestic fruit jars 26 per cent. These declines were offset by increases of 120 per cent in beer bottles, 21 per cent in narrow-neck food containers and 7 per cent in medicinal and toilet ware. Total shipments for the first five months of 1942 amounted to 32,926,000 gross, or a gain of 29 per cent over last year. Increases were reported for all lines, with the exception of pressure and non-pressure ware, over last year's comparable period. Largest gains were achieved in beer bottles (up 146 per cent), domestic fruit jars (up 125 per cent), and domestic jelly glasses (up 120 per cent). Other increases were as follows: narrow-neck food containers 66 per cent, wide mouth food containers 33 per cent, medicinal and toilet ware 18 per cent, pressed food ware 13 per cent, liquor ware and general purpose ware 12 per cent, and milk bottles 9 per cent. Sales of pressure and non-pressure ware declined 4 per cent.

THE GLASS INDUSTRY'S INDEX

Monthly Trends Through May, 1942



CURRENT GLASS CONTAINER STATISTICS

(ALL FIGURES ARE IN GROSS)

Types of Ware	*Production*		*Shipments*		*End of Month Stocks*	
	May, 1942	*May, 1941*	*May, 1942*	*May, 1941*	*May, 1942*	*May, 1941*
Food Containers (Narrow neck, wide mouth, and pressed)	2,186,988	1,638,367	1,956,868	1,587,202	2,291,247	2,039,540
Pressure and Non-Pressure	454,944	627,170	507,844	779,044	539,870	727,876
Beer	1,118,208	569,097	1,158,141	548,345	302,184	857,396
Liquor	799,689	956,340	813,678	987,825	1,724,075	1,380,991
Medicine and Toilet Ware	1,778,589	1,647,915	1,733,303	1,608,099	3,156,508	2,969,936
General Purpose Ware	473,384	469,623	441,403	454,963	557,756	533,652
Milk Bottles	242,605	257,657	259,129	271,438	380,158	278,423
Fruit and Jelly	116,193	49,346	104,117	136,375	493,985	410,836
All Other	21,075	27,930	22,330	24,510	43,207	45,117
Total Industry	7,191,675	6,243,445	6,996,813	6,397,801	9,488,990	9,243,767

Inventories of glass containers as of May 31, 1942, totalled 9,488,990 gross—3 per cent above the 1941 level. Increases were reported for all lines except narrow-neck food containers and pressed food ware, pressure and non-pressure ware, beer bottles and domestic jelly glasses.

Miscellaneous glass products manufactured were valued at $16,000,000 according to reliable estimates. This compares with $12,000,000 in May 1941.

According to a preliminary report of the Bureau of Census, 13 illuminating glass ware manufacturers reported sales totalling $813,000 during May, which was 8 per cent under May 1941 and 12 per cent under April 1942.

Manufacturers' sales of machine-made table, kitchen and household glassware were reported at 2,926,731 dozens, or 13 per cent less than last year's comparable month. During the 12-month period ending May 31, 1942, this trade increased 7 per cent over the previous 12 months' total to 37,941,519 dozens.

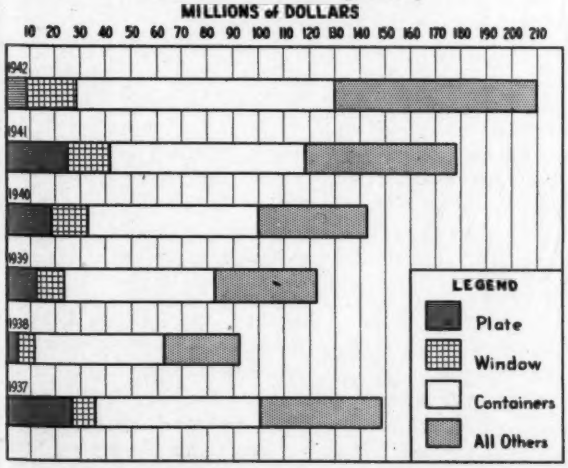
Automatic tumbler production during May amounted to 4,134,204 dozens—25 per cent less than in last year's comparable month. During the January-May period this output increased 15 per cent over 1941's comparable months to 23,442,131 dozens. Shipments of automatic tumblers during May dropped 15 per cent below last year's corresponding month to 4,314,707 dozens. Total shipments for the five months ending May reached a volume of 21,471,029 dozens—5 per cent ahead of last year. Stocks on hand at the close of May totalled 8,878,768 dozens—12 per cent higher than in 1941.

Employment and payrolls: Employment in the glass industry during May continued at the level of the previous two months with an estimated 92,000 persons. This compared with approximately 86,000 persons in May 1941.

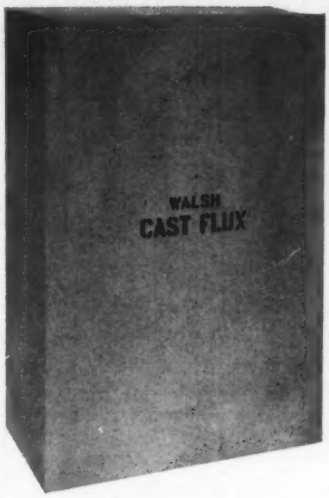
Payrolls in the glass industry during May also continued at recent levels, being estimated at approximately $12,500,000. During the first five months of 1942 glass manufacturers paid out over $60,000,000 in wages. Last year's comparable figure was about $50,000,000.

GI THE GLASS INDUSTRY'S INDEX

Production Through May



WALSH CAST-FLUX



The Vacuum-cast flux block of superior quality.

Walsh Cast-Flux blocks are machine-trued to exact size and shape after burning.

THEY LAST LONGER

The excellent results obtained in numerous tanks melting various types of glass has definitely established the efficiency and economy of Walsh Cast-Flux blocks.

Walsh Cast-Flux has a dense, uniform structure; it is burned at higher temperatures, is thoroughly bonded and possesses a low coefficient of expansion.

Walsh Cast-Flux blocks meet the most rigid requirements for tanks operating at higher temperatures . . . they insure greater tonnage, higher quality glass, freedom from defects, longer life and maximum economy.

WALSH REFRACTORIES CORPORATION

Manufacturers of Refractories for the glass industry for over 50 years

4428 North First Street
St. Louis Missouri

Lime, essential in glass

is also essential in building

Just as Banner Lime is serving an essential purpose in the manufacture of all kinds of glass—food containers, flat glass, illuminating ware, table ware, glass blocks—so it is going into vital war construction such as defense housing projects and defense plants.

The same qualities of uniformity—both in chemical content and manufacture—low impurity content and dependable supply, make Banner Lime desirable for both these vital war needs.

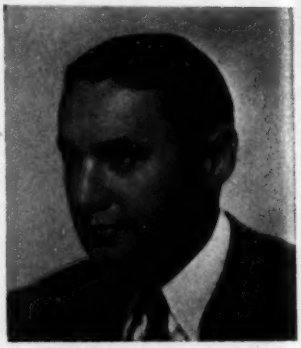
In four *essential* industries—glass, steel, building, and agriculture—lime and limestone are *essential*. Banner Lime is doing its part to help win this war. National Mortar and Supply Company, Pittsburgh, Pa.

Since 1907 a good company to do business with

HEAD OF OWENS-ILLINOIS CLEVELAND SALES OFFICE

Announcement has recently been made of the appointment of Emmett P. O'Rourke as Branch Manager of the Cleveland sales office of the Owens-Illinois Glass Company to succeed the late Richard Haley. Mr. O'Rourke has been a member of the Owens-Illinois sales organization since 1923, serving in Detroit, Cincinnati, Chicago and New York where he is at present located. In 1940 and 1941 he achieved the distinction of the presidency of the 111 Club, an honor accorded to the salesman making the best sales-to-quota record in territory east of the Rocky Mountains.

E. W. RITTER ASSISTANT TO PRESIDENT OF CORNING GLASS WORKS



Mr. E. W. Ritter, formerly Vice President in Charge of Manufacturing and Production Engineering of the Radio Corporation of America Manufacturing Co., Inc., has been appointed Assistant to the President of Corning Glass Works. A graduate in Electrical Engineering at Purdue University in 1925, Mr. Ritter was associated with the General Electric Company for five years and then, in 1930, joined RCA Mfg. Company. In his new position he will be actively engaged in development, engineering and manufacturing matters relating to war products.

FRANK CLARKE APPOINTED GEN'L MANAGER OF WAREHOUSES FOR PITTSBURGH PLATE

The Pittsburgh Plate Glass Company has appointed Frank Clarke as general manager of warehouses. Mr. Clarke joined the Company at its Atlanta branch in 1913 and since then has been located in Louisville, Kentucky, and in St. Louis as local manager. He has been district manager in St. Louis since 1934.

Throughout his career Mr. Clarke has been active in glass and paint industry affairs, serving as President of the St. Louis Glass, Paint and Lacquer Association in 1935. He succeeds B. J. Cassady who has been with the Company 44 years and who has resigned due to ill health.

• Charles R. Johnson has been appointed to OPA in charge of the optical goods unit of the consumer durable goods branch. Mr. Johnson was formerly president of the General Optical Company and the Kryptok Company, both of Mount Vernon, N. Y., and vice-president of the Shur-on Optical Company of Geneva and Rochester, N. Y.

ANTI-TRUST SUIT CONCLUDED

The government's anti-trust suit against major glass container manufacturers recently resulted in the dismissal of 16 individual defendants. Dissolution of the Hartford-Empire Glass Company, Hartford, Conn., charged with accumulation of patents in violation of the anti-trust laws and the establishment of a monopoly, was asked by government attorneys. It was suggested that the Court might request all parties involved to submit plans for dissolution and that compulsory licensing, royalty free, be made on all patents involved in the case.

The 16 defendants dismissed were: F. T. Nesbitt, H. W. Sherwood, F. J. Solon and C. J. Wilcox, Owens-Illinois Glass Co; Arthur E. Ball and A. M. Bracker, Ball Bros. Co; Glen W. Cole, W. C. Decker, George B. Hollister, P. W. Jenkins, George D. MacBeth and John L. Thomas, Corning Glass Works; John C. Hostetter, Hartford-Empire Co; S. O. Laughlin and A. L. Metzner, Hazel-Atlas Co., and F. H. Mills, Thatcher Manufacturing Co.

CHEMICAL SHOW NOVEMBER 17-22

The second biennial National Industrial Chemical Conference and Exposition, sponsored by the American Chemical Society, will be held November 17-22 at the Stevens Hotel in Chicago. Due to the important part played by chemistry in the solution of war problems it is expected that the demonstrations of chemical advancement and the participation of foremost personalities in the industry will make this a record-setting meeting. Over 75 per cent of the available exhibition space is reported already under contract.

FOAMGLAS, NEW TYPE GLASS

Foamglas, an opaque glass which floats like cork, with valuable insulating qualities and one-fifteenth the weight of ordinary glass, has been developed by the Pittsburgh Corning Corporation and is now in production. The new product is under active federal investigation as an alternate for critical products such as cork, balsa wood, cellular rubber and kapok. It has a cellular structure containing myriad tiny air-tight cells which give the product its buoyancy and insulating properties.

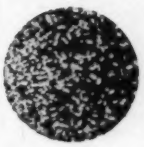
Foamglas is odorless, fireproof and vermin proof. It is particularly useful in the low-temperature insulation field where it can be used in rooms in meat-packing plants, breweries, dairies, ice cream plants, etc. The slabs are available in sizes 12 x 18 inches with thicknesses of 2, 3, 4½ and 6 inches. Foamglas is produced by firing ordinary glass which has been mixed with a small quantity of pure carbon. As the glass softens, the carbon turns into a gas which acts upon it as does baking powder or yeast on bread. By careful control it is possible to obtain rigid vitreous slabs of Foamglas with uniformly small cells and entirely sealed one from another.

• Overmyer Mould Company of Winchester, Indiana, has added 14,000 square feet of space to its present facilities in Winchester. The new building to be occupied about July 1 will house the entire office force on the second floor. The ground floor will provide 7,200 square feet for machine shop operation. The old office will be utilized for engineering and plant planning.

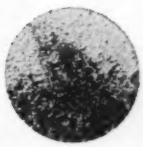
"Re-tooling" Glass Production

MODERN GLASS is the result of new, improved technology—and new types of basic materials. Here are outstanding factors in this "tooling up" of glass production — all BETTER MATERIALS produced by Solvay:

SOLVAY DUSTLESS CALCINED POTASSIUM CARBONATE 98-100%
Especially developed by Solvay for the glass industry. Used to produce special glass such as optical glass and fine stemware, this product was a major development for the glassmaker. Dust from potassium carbonate is a serious nuisance to workers and is particularly damaging to the costly glass furnaces. It decreases the life of expensive fire brick, lowers the efficiency of heat transfer and otherwise seriously interferes with equipment and processing. Solvay Calcined Potassium Carbonate *is free from dust* and therefore prevents costly losses. Its "homogeneous" physical characteristics, as in the case of Solvay Dustless Dense Soda Ash, result in important production savings.



SOLVAY DUSTLESS DENSE SODA ASH—*Especially developed by Solvay for the glass industry.* Highly pure, highly uniform, for all practical purposes free from dust. Dust interferes with processing and is a source of irregularities in the glass. Physical characteristics of this product are so determined with respect to density and granulation, that there is perfect blending with other ingredients to produce a purer glass. Prevents loss of valuable materials and helps maintain control over glass melts, which is an important key to quantity production.



SOLVAY GRANULAR HYDRATED POTASSIUM CARBONATE 83-85%
This form of Potassium Carbonate is available for those who prefer a hydrated type. A high quality granular product, also essentially free of dust.

AN OUTSTANDING TECHNICAL SERVICE FOR GLASSMAKERS—Solvay is particularly well equipped to render technical assistance on glassmaking problems as they relate to the use of alkalies. Prompt and individual attention by recognized glass technologists is given all inquiries.

★ ★ ★

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THE O. HOMMEL COMPANY
209 FOURTH AVE. PITTSBURGH, PENNA.
Phone WAlnut 1195

"NEW WAYS TO SELL MORE GLASS"

Libbey-Owens-Ford Glass Company has recently published a portfolio with the above title designed to assist the glass dealer in building up business. The folder carries a real punch and should stimulate even the layman to a keen interest and appreciation of the tremendous possibilities offered by glass in everyday life.

The portfolio contains three pockets. In the first is a 36 page booklet "Practical Ideas for Today's Homes." Promotional suggestions are included in the second pocket . . . assorted publicity stories, a pamphlet of mat-proofs offered free, etc. The third pocket contains a folder showing specifications for installing the glass features illustrated in the 36 page booklet.

• The War Production Board and other war agencies have several openings for men experienced in all fields of glass and also in stone, clay products and pottery, concrete, gypsum, plaster products, abrasive, asbestos and miscellaneous non-metallic products. Duties include directing priorities, substitution or price control programs, liaison representatives with manufacturers of equipment, evaluating data in industrial reports. Further information may be obtained by writing the United States Civil Service Commission in New York City.

• All persons claiming interest in patents or patent applications now or formerly owned by nationals of designated foreign countries should report their interest on Form APC-2 by *August 15th, 1942.*

THE USE OF ARSENIC IN THE GLASS INDUSTRY

(*Continued from page* 257)

oversensitivity to solarization and strict control over the cullet and batch ingredients is the only means to eliminate this defect.

The poisonous character of arsenic is not transferred to the glass, when glasses of good durability are used for bottles and food containers. The health hazard is limited to the man in the glass house and even here, it could be considerably decreased by the use of insoluble pentavalent arsenic compounds.

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ONE EXTRA TOOTH

(*Continued from page* 260)

tained, and when their demand could not be met, Stilwell was the first to be sacrificed. This was apparently early in 1928. But the sacrifice naturally produced no technical result, and the next victim was Frank Troutman himself. Again no useful result followed, and the next step was to cut wages. This was done in a rather drastic and sudden fashion, and produced a strike (Nov. 1928), which of course was equally without beneficial results. The final bankruptcy of the company was not long delayed.

In 1929 the Great Depression began, and Frank Troutman and George Stewart organized a company to rent the premises of the Standard Plate and operate it once more. The venture was sufficiently successful that after a while European interests bought the place, renamed it the Franklin Glass Corporation, and have continued to operate it, with improvement, ever since. The "continuous" had been gathering dust for some years; the new Corporation decided to give it a trial run, to see the wheels go round, and then scrapped it. Neither Grice nor Sawyer, neither Troutman nor Carrie was present to see the last turning-over of the machinery; but Carrie, from his workshop at the Preston Laboratory (old location) saw the freight cars go by with the last wreckage of his hopes of earlier years.

Frank Troutman and Richard Stilwell died within five days of one another as winter descended on the first year of the Second World War. Carrie remained till April 19th, 1942. The fortunes of all three had been destroyed some fifteen years before but each had demonstrated a worth-while accomplishment in the years that followed, and came within sight of proving that others of their ideas were sound. They did not recoup their fortunes, but they did help their industry and their community. Troutman showed that the old plate glass plant could operate, in spite of lack of capital, in the midst of a depression. It seems to have been the only plate glass plant that ever did stage a come-back. The machines that Carrie (and McCormick) developed at the Preston Laboratories are now in use all over the States, Canada, in Europe, and Asia.

Except for that one unlucky tooth, the story might have been very different, but none can say definitely that it would have been better. That it caused untold suffering is certain. That the suffering purchased nothing worth while is far from certain. Now that they are gone, we report their lives as objectively as we can, remembering the things they told us through the years, appraising their motives and their judgment with our own fallible judgment, and paying our tribute to men who failed by a very narrow margin. In their failure, though it cut deeply into their souls, they were not embittered; and till the end they extended their help to all whom their resources could reach. Requiescant in Pace.

• Harry F. Reid, Jr., has been appointed a research engineer on the technical staff of Battelle Memorial Institute, Columbus, Ohio, and has been assigned to ceramic research. Mr. Reid was formerly associated with the Ceramic Color and Chemical Manufacturing Company, Brighton, Pennsylvania.

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FOAM GLASS

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diameter. While the mechanical strength will decrease with increasing pore size the heat insulating properties will increase therewith.[5] Sound insulation will be more dependent on the apparent density and will increase with decreasing density, while the actual pore size will be of lesser influence.[1] In this connection it is interesting to note that partial destruction of the cell walls, for example, by rapid cooling from 350° to room temperature[2b] is reported to greatly increase the sound insulating properties of foam glass building blocks. The sound insulating capacity of regular foam glass is reported to be about the same as that of common brick.[1]

The apparent density may be anywhere between .15 and .50 as compared with 2.5 for the average solid glass. The heat conductivity of an average foam glass will be better than that of hollow glass bricks and similar to that of diatomite brick and even as low as that of cork agglomerates.[1] It goes without saying that the mechanical strength of foam glass is much lower than that of solid glass. Its resistance to compression of about 40 kg. per sq. cm will be satisfactory for most purposes. However, local impact will be less harmful for foam glass since radial propagation of a blow will be greatly diminished and the damage will be local only. Due to this fact cellular glass can be sawed, nailed, groved and in many other ways treated like wood rather than glass.

It may be premature to be as optimistic as one author[3] who reported that cellular glass prepared according to his process will replace wood in almost all respects and may also be used as a substitute for paper, artificial leather and for the manufacture of safety glass. At least some reporters[4] prefer to wait for more practical results before discarding wood as a useful raw material. However, disregarding individual claims it may be well foreseen that careful adjustment of pore distribution, pore shape and size as well as selection of glasses of different properties and heat treatment of the glass proper may lead to further far reaching improvements of this promising material.

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[1]Some Properties of "Multicellular" Glasses. B. Long. Jour Soc. Glass Tech. T. 20, 181-187 (1936).
[2]Multicellular Glass and the Possibilities of its Utilization. F. Goldis. Verre & Sil. Ind. 10, 199 (1939).
[4]Abstract of 3. in Glast. Ber. 17, 259 (1939).
[5]Production of Foam Glass. I. I. Kitaigorodski & L. M. Butt, abstracted in Glast. Ber. 19 (3), 101 (1941).
[12]Enamel. R. Turk. U. S. 2,053,244 of Sep. 1, 1936 (Dec. 28, 1935).
[2b]2,237,032 of Apr. 1, 1941 (Feb. 19, 1938). Process of Increasing the Sound Absorptive Properties of Cellular Glass. E. H. Haux (Pittsburgh Plate Glass Co.).

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